

DOC. MANAGEMENT
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MERCURY RESTORATION PROGRAM



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Submitted By:
The IT Group

N0007597

Environmental Engineers • Scientists • Constructors

QA/QC

N0007598



1.0 GENERAL

1.1 INTRODUCTION

This plan describes the quality organization, system, and processes for assisting NICOR with its mercury testing and property cleanup activities. Once approved by the Mercury Task Force, this document will become a controlled document and will be managed under the provisions of Section 2.7.1 herein.

The objective of this plan is to ensure that screening and property cleanup activities are performed in accordance with established plans, procedures, protocols and are appropriately documented.

The primary scope of work involves applying IT's technical and program management expertise to ensure the overall success of the project in terms of quality, efficiency and effectiveness. In general, IT will provide:

- Overall project oversight;
- Implementation of a comprehensive quality assurance/quality control program for training, inspection/screening, cleanup, final clearance and waste handling;
- Data analysis relating to potentially impacted sites;
- Ongoing review of protocols and procedures for training, inspection/screening, cleanup, final clearance and waste handling; and,
- Ongoing assessment of overall activities as outlined within approved plans.

Quality control will be the most important element of each task performed. The process will be implemented within the line organization where it will be most effectively applied. In conjunction with operations and other project activities, a comprehensive program for evaluation and assessment will be implemented for the quality assurance group.

1.2 DEFINITIONS

Measuring & Test Equipment (M&TE) – devices or systems used to calibrate, measure, gauge, test or inspect in order to control or acquire data to verify conformance to specified requirements.

Corrective Action – measures taken to rectify conditions adverse to quality and where necessary, to prelude recurrence.



1.0 GENERAL

Quality Control – the overall system of technical activities that measures the attributes and performance of a process, item or service against defined standards to verify that they meet the stated requirements of the customer.

Quality Assurance – an integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item or service is of the type and quality required to meet program objectives.



2.0 QUALITY MANAGEMENT SYSTEM

2.1 MANAGEMENT AND ORGANIZATION

The organization established for this project is depicted in Figure 2.1. Positions are shown to reflect the organizational lines of reporting, authority, communication and interface.

2.1.1 Program Manager

The Program Manager will be responsible for overall quality performance and administration of the project.

2.1.2 Operations Managers

Each Operations Manager is delegated the responsibility for quality performance, management and administration of daily operations activities.

2.1.3 Project Managers

Each Project Manager will report directly to the Operations Manager, and will be responsible for the management and execution of activities in accordance with the statement of work, approved work plans, federal, state, and local laws and regulations. Each Project Manager will be responsible for the quality of work, project administration, and timelines of project activities, including those performed by subcontractors and suppliers.

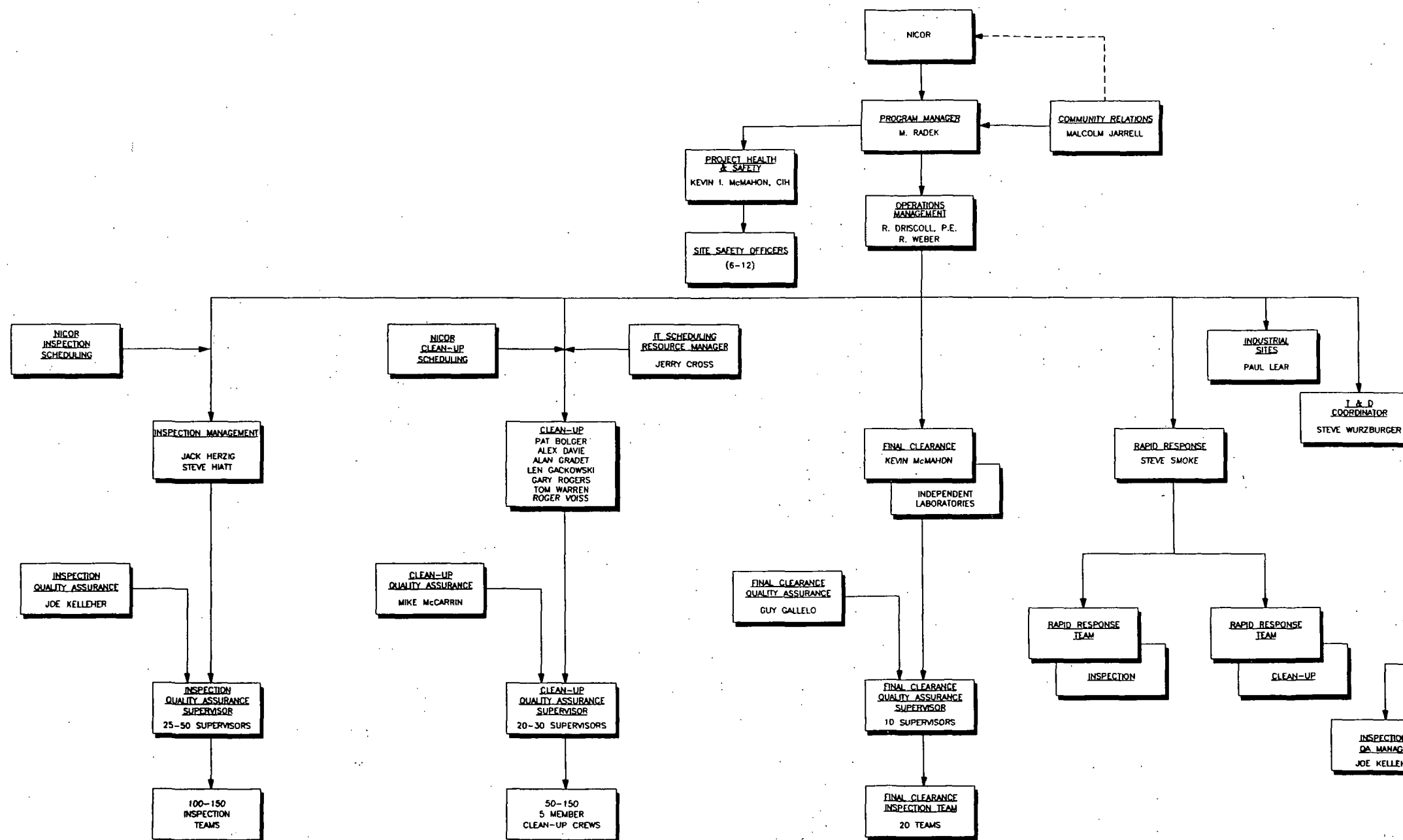
2.1.4 Program Quality Assurance Manager

The Program Quality Assurance Manager will be responsible for implementing the quality assurance evaluation assessment process while assisting the Program and Operations Management Team. This individual will independently report to the IT Corporate Quality Assurance Manager for all matters involving quality.

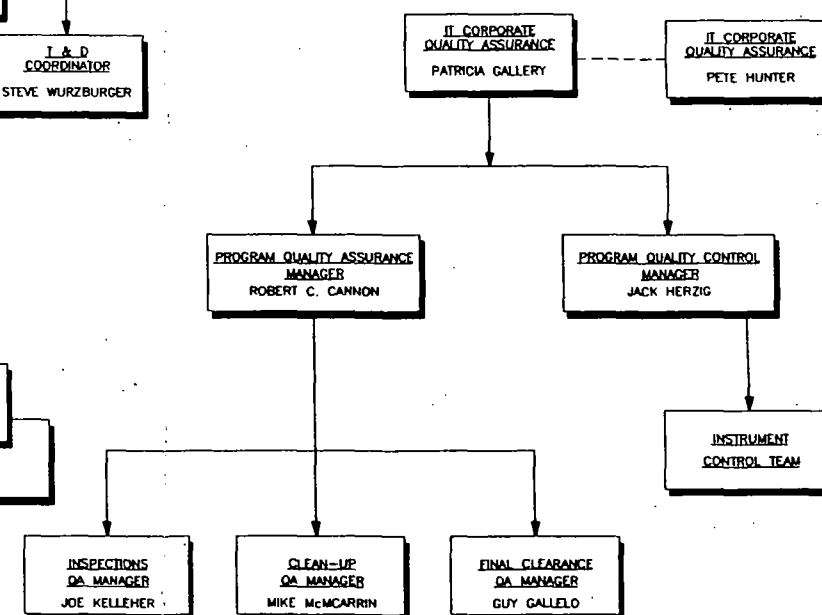
2.1.5 Quality Assurance Manager

The Quality Assurance Manager will be responsible for planning and performing scheduled program evaluations and assessments. The results of each assessment will be documented in a formal report that will be issued for information, corrective action and improvements.

INSPECTION AND CLEANUP OPERATIONS



QUALITY ASSURANCE



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NICOR
CHICAGO, ILLINOIS

FIGURE 2-1
MERCURY RESPONSE TEAM
ORGANIZATION CHART
NICOR
CHICAGO, ILLINOIS



2.0 QUALITY MANAGEMENT SYSTEM

2.1.6 Quality Control Manager

The Quality Control Manager will be responsible for planning and performing quality control evaluations and assessments of the screening instrumentation. The results of each QC assessment will be documented in a report and issued for information and/or corrective action.

2.1.7 Quality Assurance Supervisors

Quality Assurance Supervisors will report functionally to his/her respective Project Manager. QA Supervisors will be assigned to the functional areas of inspection, clean up or final clearance. The duties and responsibilities of each QA Supervisor shall include, but not be limited to:

- Evaluating the real time performance of inspection, cleanup, final clearance activities;
- Implementing immediate corrective action measures; and
- Documenting the results of activities performed.

2.2 QUALITY SYSTEM

The quality system provides for measures to ensure that work is performed under suitable controlled conditions. Specifically, the system will focus on key activities that will include but not be limited to the performance of initial screening, instrument inspections, cleanup, rapid response and clearance activities.

2.3 PERSONNEL INDOCTRINATION AND TRAINING

Personnel indoctrination and training in mercury testing and cleanup activities will be provided as part of the individual's project indoctrination, prior to the assignment of quality-related tasks. Records of training will be submitted to the Program Quality Assurance Manager for review and retention.

2.3.1 Health and Safety Training

Health and Safety (H&S) training requirements are to be established in accordance with established policies and procedures and will be specified within the Health and Safety Plan (HASP).

2.4 CONTROL OF MEASURING AND TEST EQUIPMENT

The Measuring and Test Equipment (M&TE) to be used for the screening, cleanup, and final clearance activities will be Jerome and Lumex mercury vapor detectors or equivalent. The control of M&TE is necessary to ensure that these devices are appropriately maintained and traceable to the location where they are used. The calibration status of M&TE is essential to



2.0 QUALITY MANAGEMENT SYSTEM

support the creditability of data and the results obtained during the performance and verification of measuring and test activities.

The selection and use of M&TE shall be controlled to assure that such items are of the proper type, range, accuracy and tolerance to accomplish the function of determining conformance to specified requirements. Each M&TE device shall be calibrated, adjusted, and maintained at prescribed intervals or, prior to use, against certified equipment and items having a known valid relationship to nationally recognized standards.

2.4.1 Identification

The party who performed the calibration to reflect its calibration status will tag each instrument or device. The information on the tag will include identification of the agency or laboratory, the initials of the individual who performed the calibration, the date calibrated and the next calibration due date. These tags may be on the instrument or device or affixed to the carrying or shipping case.

2.4.2 Control

The control of M&TE shall be established by ensuring that each device is entered into the M&TE Inventory. Information to be entered into the inventory shall include the following:

- Equipment Type & Manufacturer
- Model & Serial Number
- Date of Last Calibration
- Frequency of Calibration
- Calibration Due Date
- Responsible Party
- Description of Use

Each item will be removed from service and calibrated prior to the calibration due date. When returned for service, the calibration test report will be reviewed by the Program Quality Control Manager and filed.

2.4.3 Instrument Calibration and Frequency

The method and interval of calibration for each item shall be defined, based on the equipment stability characteristics, required accuracy, intended use, and other conditions affecting measurement control. Generally, the prescribed interval or frequency of calibration will be recommended within the manufacturers' instructions.



2.0 QUALITY MANAGEMENT SYSTEM

When M&TE is found to be out of calibration, an evaluation shall be made and documented to the validity of previous inspection and test results, and of the acceptability of activities performed with the M&TE. Out of calibration devices shall be tagged or segregated and not used until they have been re-calibrated. Any device consistently found to be out of calibration, shall be repaired or replaced.

Recommendations for proper handling and storage may be found in the manufacturers' instruction and shall be followed. (See Appendix A).

Instrumentation both in the field and at the laboratory must be calibrated to ensure accurate results. Calibrations must be verified at defined times and performance criteria established in accordance with the manufacturers' recommendations.

2.4.3.1 Calibration Standards

The manufacturer must certify all standards used to calibrate field monitoring instrumentation. Purchased standard solutions for laboratory uses must be traceable to NIST materials and must be obtained with their accompanying documentation. All standards shall be assigned unique tracking numbers and be entered into a bound standard notebook. All standards must be labeled with:

- Standard number
- Description/concentration
- Initials of person who made the standard
- Date standard was made
- Expiration date

Standards shall be stored and maintained in accordance with Table 2.1.

Table 2.1: Calibration Standard Storage

Standard Type	Storage	Expiration
Field Mercury Calibration		
Functional Standard Test	Room Temperature	6 months
Laboratory Calibration Standards		
pH Buffers	Room Temperature	6 months
CVAA stocks	Room Temperature	6 months
Intermediates	Room Temperature	1 month
Working standards	Room Temperature	Fresh Daily

2.0 QUALITY MANAGEMENT SYSTEM

2.4.3.2 Calibration of Instrumentation

The following sections summarize the requirements for calibration for both field (mercury screening) and laboratory processes.

2.4.3.3 Screening Instrument Calibration

The Jerome Mercury analyzers are factory calibrated by the manufacturer, Arizona Instrument, and require limited calibration and checks. However, in order to maintain a defensible quality standard in the screening effort, the following requirements will be imposed upon the Jerome analyzers as summarized in Table 2.2. All Jerome calibration and functional test records will be maintained in a central location. This information will also be tracked on a spreadsheet.

Table 2.2: Summary of Calibration Procedures for Field Screening

Calibration	Minimum Frequency	Acceptance Criteria	Corrective Action	QC Requirement
Jerome Mercury Analyzers				
Negative check (analysis of outside/non-impacted air with zero-air filter in place)	Daily following Regen procedure and balance of Zero	<0.002 mg/m ³	Repeat a total of three times-after re-adjusting Zero. Replace zero-air filter and repeat. If the problem is not corrected, remove instrument from use and Red Tag.	If instrument cannot Zero, there is little confidence in results. Instrument MUST NOT be used
Positive check (Functional Performance Check)	Monthly- following a Regen/Balance procedure or whenever major maintenance is performed. Also, whenever instrument is first received from vendor/rental agent	Within range for standard vessel temperature in Temperature Conversion Chart	Repeat if still not passing. Refill Calibration Vessel and retest. If still does not pass, Red Tag non-functional instrument	If instrument cannot meet stated criteria it MUST NOT be used
Air-sampling Pumps				
Check / calibrate flow rates	Daily	Must be adjustable to within 5% of stated flow	Inspect pump tubing for kinks/blockage.	If pump will not meet specification- Red Tag and remove from service

2.4.3.3.1 Laboratory Calibration Procedures

The Final Clearance analysis may be performed on collected filters using NIOSH Method 6009. In the performance of this method, the subcontractor laboratories will be required to follow the calibration protocols summarized in Table 2.3.

2.0 QUALITY MANAGEMENT SYSTEM

Table 2.3: Summary of Calibration Procedures for Laboratory Analyses

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria
pH Meter				
Calibrate with 2 buffers and check with a third	Daily	Checked buffer must be within +/- 0.25 units	Clean electrode repeat	N/A
Analytical Balance				
Calibration by certified technician	Yearly	N/A	N/A	N/A
Check with certified weight	Daily	+/- 5% of certified weight	Clean balance pan surface and repeat	If problem persists, consult service technician
Atomic Absorption, GFAA, and CVA				
Multipoint calibration curve (minimum three standards and a blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥ 0.995 for linear regression	Correct problem, then repeat initial calibration	Apply "R" to the specific analyte result for all samples associated with the calibration
Second-source calibration verification	After each new stock standard preparation	Analytes within $\pm 10\%$ of expected value	Correct problem, then repeat initial calibration	Apply "R" to the specific analyte result for all samples associated with the calibration
Continuing calibration verification	After every 15 samples and at the end of the analysis sequence	Within $\pm 20\%$ of expected value	Correct problem, then repeat initial calibration and reanalyze all samples since last successful calibration	Apply "R" to the specific analyte result in all samples since the last acceptable calibration verification

2.5 QUALITY CONTROL

2.5.1 General

The primary purpose of the quality control program is to verify the proper use of M&TE in accordance established protocols and instructions and to verify that M&TE are calibrated and performing properly.

2.5.2 Quality Control Planning

The extent of QC planning is driven by the status of affected locations, access, and availability of resources allocated toward the overall effort.



2.0 QUALITY MANAGEMENT SYSTEM

The status of the daily calibration checks and calibration status of each M&TE will be continually monitored. In the event that an M&TE is utilized without a daily calibration check, 10% of the measurements will be rechecked to evaluate whether all of the measurements need to be repeated.

2.5.3 Checklist Development

Quality Assurance Checklists (See Appendix B) shall be used to ensure consistency and provide guidance for the individuals performing the quality assurance function. The checklist includes quality attributes to be evaluated, as appropriate, including:

- Name of the Inspection Supervisor,
- Name(s) of the Survey Team Members,
- Date of evaluation and assessment,
- Property,
- Indication of observation/Follow-up review,
- Identification of the M&TE used,
- Calibration due date,
- Status of daily calibration checks.

2.5.4 Daily Quality Control Reporting

Each Quality Assurance Supervisor will prepare a Daily Quality Assurance Memorandum summarizing the decisions and activities verified and any corrective actions implemented. Completed checklists will be attached to the Daily Quality Assurance Memorandum and submitted to the applicable Project Manager for review.

2.5.5 Weekly Quality Control Coordination Meetings

Quality Control Coordination meetings will be held on a weekly basis to discuss current quality issues. The meetings will be chaired by the Assistant Program Manager with members of the QA management team. Minutes of the meeting shall be prepared and distributed to the project management team.

Can we get minutes

2.6 EVALUATION AND ASSESSMENTS

Evaluation and Assessment (E&A) activities will be conducted by each member of the QA organization. The results of each E&A activity will be documented in a formal report to be submitted to the respective Project Manager.



2.0 QUALITY MANAGEMENT SYSTEM

Corrective actions will be immediately implemented upon the identification of unacceptable deviations or deficiencies. The results of corrective actions will be documented in the E&A report.

2.7 DOCUMENTATION AND RECORDS

2.7.1 Document Control

Documents to be controlled shall be identified, controlled and distributed for use in the work location where they are used.

The Program Manager will designate a Document Custodian who will be responsible for:

- Maintaining a list of documents identified for controlled distribution (Figure 2.2 Controlled Document Record Card).
- Distributing controlled documents via use of the Document Transmittal Receipt Form (Figure 2.3) to those designated for distribution.
- Control and maintain original documents within the project files.

Upon receipt, the recipient will sign and date the Receipt Acknowledgement and return the Transmittal Form to the sender. Copies of all completed transmittal forms will be sent to the document custodian.

2.7.2 Records

The records system shall be established at the earliest practicable time consistent with the schedule for accomplishing work activities.

Provisions for the processing of records shall be addressed within the plans, procedures and protocols that govern the activity or process.

Records will provide sufficient information to permit identification of the applicable item or activity. Each record shall be legible, accurate and completed appropriate to the work accomplished. Each record will be signed and dated.

Provisions shall be established for receipt, review, presentation and safekeeping of record originals until time of submittal or transfer. Both originals and copies of quality records:

- Shall be maintained and organized within the project files, and
- Shall have access limited to only authorized personnel.

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[illegible]

FIGURE 2.3
IT DOCUMENT TRANSMITTAL FORM

IT DOCUMENT TRANSMITTAL FORM & RECEIPT ACKNOWLEDGEMENT		
To:	From:	Date:
<p>Instructions: The following documents are being transmitted for your information and use. Please acknowledge receipt by signing and dating the receipt acknowledgement line at the bottom of this page and return the acknowledged transmittal form to the originator. Superseded revisions or issues are to be:</p> <p><input type="checkbox"/> Returned to the name and address indicated below.</p> <p><input type="checkbox"/> Destroyed.</p>		
Document Identification & Title	Revision / Issue	# of Copies
<p>Acknowledgement Signature & Date: _____</p> <p>Return name and address:</p> <p>DOCUMENTS PROVIDED WITH THIS TRANSMITTAL SHALL NOT BE COPIED OR DISTRIBUTED TO OTHERS.</p>		



2.0 QUALITY MANAGEMENT SYSTEM

2.8 PROTOCOL CONTENT REVIEW GROUP

To ensure that protocols, and any changes thereof, are controlled for content, reviewed, and accepted, a Protocol Content Review Group (PCRG) will be established with a single point of contact. *when*

The PCRG will be comprised of management and technical personnel from NICOR, IT Corp. and others as necessary. PCRG function responsibilities and review process will be described in a Standard Quality Practice (to be developed).

2.9 QUALITY IMPROVEMENT

An ongoing process for quality improvement will be established and implemented by the Program Management team.

The process will be receptive to recommendation from both internal and external customers. This shall include but not be limited to the following:

- A suggestion process accessible to all project personnel;
- The establishment of Quality Focus Teams to address and recommend improvements to complex issues or processes; and
- A formal process that is immediately responsive to the recommendations provided by NICOR.

2.10 INDEPENDENT QUALITY ASSURANCE

In order to provide additional credibility and an increased level of confidence, NICOR will procure the service of an independent quality assurance group to evaluate and assess the IT oversight activities with respect to final clearance screening. IT shall be responsive to the findings presented by the independent quality assurance group. At a minimum, the independent quality assurance group will evaluate no less than 10% of final clearance screening evaluations and assessments performed by IT. *who*

3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL MEASUREMENT DATA

Completion of the assigned task requires extensive amounts of qualitative and quantitative environmental measurement data. Several project decision points depend upon the acquisition, interpretation, assessment, and management of data that is of a known and sufficient quality to support the decisions in a legally defensible manner.

3.1 GENERAL DESIGN ELEMENTS AND OBJECTIVES

The objective of these activities is to identify and mitigate any mercury contamination in residential and industrial/commercial properties that pose a threat to human health and/or the environment. This action will entail:

- Make a visual survey of potentially affected properties to ascertain whether or not mercury containing gas regulation apparatus are or were once present;
- Make a visual survey of potentially affected properties deemed to have contained mercury containing regulation equipment for the presence of visually detectable mercury contamination;
- Conduct vapor screening of properties to ascertain if mercury vapor concentrations are elevated within the immediate vicinity of the former regulator location and in living and other high traffic areas within the property;
- Remove and properly dispose of any contamination determined to be present; and
- Conduct hopcalite screening of remediated properties to confirm the removal of contamination below the established action levels.

During the execution of these tasks, several qualitative and quantitative data based decisions will be required. The environmental measurement objectives of this project are to perform the following tasks:

- Determine by physical survey, whether properties contain, or once contained, mercury containing gas-regulating equipment;
- Determine by visual survey if visible mercury contamination is present;
- Determine by chemical vapor screening whether or not mercury vapors are present above action-levels and identify potential contamination areas;
- Confirm removal of contamination by vapor monitoring of remediated properties; and Characterize project generated waste materials (PPE, debris etc.) for proper and regulatory compliant final disposition.



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

Flow chart Figures 3.1 through 3.4 are provided for visual and instrument screening, property cleanup and final clearance.

3.1.1 Data Types and Uses

The data types and uses that will be used to complete this project include the following:

- **Identification of potentially contaminated properties** – NICOR records have been used to ascertain the areas where mercury containing regulation equipment may have been located and removed. This information will then be used to create survey lists of potential properties requiring physical and/or chemical survey to determine if mercury contamination is present.
- **Survey of potentially contaminated properties** – Physical, visual, and chemical vapor screening surveys will be performed to determine if a property is contaminated by mercury. Strict documentation requirements will be used to record both visual observations and chemical data results. Residential properties with mercury levels above 0.003mg/m^3 and industrial/commercial properties with levels above 0.010mg/m^3 will be identified as requiring clean-up action.
- **Determination if clean-up actions have been successfully executed** – Vapor monitoring with off-site laboratory analysis of sampling media will be utilized to determine if clean-up actions have achieved the required goals.
- **Characterization of project generated wastes and determination final disposition of materials** – If deemed necessary by the T&D Coordinator, off-site analysis will be performed on composite samples of debris, PPE, and other waste materials to develop waste profiles and determine final disposition.

Table 3.1: Project Action-levels	
Property Type	Action Level
Screening Action Level	$\geq 0.003\text{ mg/m}^3$
Residential- Clearance Level	0.0003 mg/m^3
Industrial/Commercial (Screening Action and Clearance Level)	0.010 mg/m^3

3.2 DATA COLLECTION OPERATIONS AND REQUIREMENTS

Throughout the course of project execution various environmental measurement data collection tasks will be needed. These measurements will be used to document and determine the need for clean-up action, track clean-up progress, confirm successful completion for affected properties, and finally to properly dispose of generated wastes.



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

3.2.1 Identification of Potentially Impacted Properties

Properties that are within the communities and areas determined to be a part of the survey and clean up operations have been identified through a search of NICOR records. The information was then used to develop a database of properties. This database was used to determine the properties that should be visually inspected to determine if the potential of mercury contamination exists.

The database will be expanded to include the results of physical inspections, visual surveys, vapor monitoring, and post-clean-up results of the identified properties.

3.2.2 Survey of Potentially Impacted Properties

Once a property has been identified as being a candidate for further evaluation, the property owner is contacted and permission to evaluate the property is obtained. This process includes:

- Visual and/or property owner interview determination as to the current or past presence of a mercury-containing regulator inside the property;
- Visual survey of the former regulator location in accordance with the NICOR/Mercury Task Force agreed procedure to determine if visible mercury is present; and
- Vapor monitoring of the former regulator location and living/use areas in accordance with the approved NICOR/Mercury Task Force procedures.

The entire process is documented on a Mercury Screening Record Form (Appendix B) for each property. This form is to be completed at the time of the inspection/survey in indelible black ink. The information from the completed form is then added to the database and evaluated to determine if:

- A follow-up inspection/survey is needed;
- The property requires clean-up and in what areas will this be needed; or
- The property can be declared as "Cleared" by NICOR, meaning no further action is needed. IT shall notify NICOR of properties where cleanup is not required.

3.2.3 Progress Monitoring of Clean-Up Actions

The clean-up areas will be screened during clean-up progress using the Jerome meters (or equivalent) to provide for clean-up worker exposure data and to track the progress of the mercury removal. This screening will be performed in the actual clean-up



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

zones identified during the initial instrument screening process. The results will be documented in Mercury Screening Record Forms (Appendix B).

3.2.4 Confirmation of Clean-up Action Completion

At the completion of clean-up activities within a property, final clearance screening will be accomplished using a Lumex detector, if approved, or by air sampling. Ambient air samples will be collected and analyzed to verify that the mercury levels are below the action limit. These samples will be collected over an 8-hr period at a minimum of five locations within the property and one location outside. The samples will be collected in accordance with the approved procedure for this task using hopcalite filter media. The samples will then be transferred under Chain-of-Custody to an AIHA approved laboratory for mercury analysis utilizing modified NIOSH method 6009 or OSHA ID-140.

The resulting data will be reviewed for QC compliance and incorporated into a Clearance Sampling Report for the property. This report will include:

- A detailed floor map showing the location of each sample and a description of the usage and occupancy of each room/area sampled;
- The Mercury Screening Record Forms from pre-closure sampling efforts and all logs/sheets documenting filter numbers, sample locations, pump flows (and checks), sampling time, actual final volume sampled, and any field notes made of unusual observations/ circumstances;
- QC reviewed and verified laboratory results; and
- A copy of the Final Clearance Sampling Protocol.

The Clearance Sampling Report will be submitted to NICOR for submittal to USEPA, ATSDR, and IDPH for review of clean-up effectiveness. Upon approval and/or its own check of the property levels, IDPH will issue a letter of clearance to the property owners/residents.

3.2.5 Documentation and Chain-of-Custody

All screening and analytical results will be maintained in files and on the database. These files will be arranged according to sample types (i.e., Visual Survey) and by property address. At the conclusion of on-site activities, all analytical data will be provided as an appendix to the project final report, arranged according to property address and sample type.

3.2.5.1 Documentation Procedures

Information herein is proprietary and confidential and to be used or released to others only with explicit written permission of IT Corporation

NICOR MERCURY
October 1, 2000

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Attorney Client Privileged

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3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

All project data sheets, inspection logs, sample labels, custody seals, Chains-of-Custody and other documents are to be completed legibly in indelible black ink. All corrections to documentation will be made by a single-line cross out of the incorrect information and proper entry above the crossed-out information. The initials of the person correcting the data and the date of correction must appear beside the corrected information.

3.2.5.2 Screening Record and Sample Numbering

Survey sheets and clearance samples will be numbered by property address. This numbering system will provide a tracking method to allow retrieval of information concerning a particular property and ensure that each survey/screening result and sample is uniquely identified. The database will be used to store the information along with descriptions of the results. For Clearance samples (hopcalite filters), each filter will be assigned a unique identifier consisting of:

Property address: Four/five letter street code-Alpha suffix (A through F) for the property locations. The location for each code shall be noted on the property clearance floor plan/map. The Field Blank shall be labeled with;

- The property address-street code-FB.
- The two filter blanks for each property should be labeled with the property address-street code-FM (1,2).

Duplicate and QA split samples will be assigned numbers (alpha suffix) as if they were additional samples and the fact that they are QA/QC samples will be noted on the site documentation only-not the Chain-of-Custody. Each filter shall be placed into a ziplock bag and a label should be attached to the bag containing:

- Sample ID,
- Date Collected,
- Flow rate and time collected,
- Total volume collected, and
- Initials of the responsible party.

3.2.5.3 Chain-of-Custody



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

Chain-of-Custody record forms will be maintained for all filter media (Clearance) samples collected during this project. It is very important that the information on the Chain-of-Custody record form match the information on the sample media. Chain-of-Custody procedures will be in accordance with USEPA procedures. The Chain-of-Custody forms will be completed, enclosed in a plastic ziplock bag, and taped to the underside of the lid on the shipping container.

SHOULD BE PART OF FINAL DATA PACKAGE

3.3 ASSESSMENT AND VERIFICATION OF DATA

The decisions being made based upon the qualitative and quantitative data being produced places extreme importance on an effective and efficient data assessment and verification system.

3.3.1 Assessment and Verification of Survey/Screening Data

Assessment and verification of the Mercury Screening Record results will consist of a two-level review process. The two levels will be designed to quickly verify that survey/screening data is being completed/documented properly and that the survey/screening process is being executed in accordance with the approved procedure. The assessment process will also provide information on the reproducibility of the survey/screening process. Assessment and verification will be conducted on both the visual and instrument screening data.

3.3.1.1 Documentation Review

The first level will be a cursory review of each submitted Screening Record Form. This review can be performed as the data is input into the database (or alternatively after input) and will consist of a review of documentation completeness, performing required instrument checks, and reasonableness of the data acquired. If any data is missing or does not fit expectations, the instrument operator will be contacted to obtain additional information. If the situation cannot be alleviated, another individual and/or a Team Leader will repeat the survey.

At least one Mercury Record Form from each team for each day will be reviewed further and compared to the calibration records for the instrument assigned to that team. This review will consist of a determination as to whether or not the instrument calibration and functional check is current and valid. If the instrument used is not currently in calibration and/or passes a functional check, ten percent of the "cleared" surveys performed will be repeated using a current instrument. If any of the results do not

confirm the cleared condition, all surveys performed that day with that instrument will be repeated.



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

confirm the cleared condition, all surveys performed that day with that instrument will be repeated.

3.3.1.2 Process Review/Oversight and Repetition

The use of screening data, such as from a Jerome meter, to declare properties as "clear" requires adequate confidence in the accuracy and reproducibility of results determined to be below action-levels. In order to instill this confidence, a combination of in-process oversight/inspection of the survey process and repetition of a percentage of "cleared" property surveys will be used to track statistical data. In addition, false-positive detections could result in unnecessary inconvenience to the property owner/resident, and costly clean-up efforts. For quality assurance, Inspection Quality Assurance Supervisors will occasionally accompany team leaders to confirm positive visual surveys and/or mercury screening efforts.

3.3.1.2.1 Review/Oversight of Survey Process

Each survey/screening team will have at least one of its survey/screening efforts witnessed/observed by an Inspection Quality Assurance Supervisor per week. The selected survey will be randomly selected from the week's appointments and the surveyor/screening personnel will not know which property the Inspector intends to witness. The Inspector will complete an Inspection Checklist during the event. He/she will note any procedural discrepancies on the form. If the Inspector observes non-compliance that could adversely affect the survey/screening results, the Inspector will review the requirements with the individual performing the survey/screening and continue to observe their execution of the process until such time that the Inspector is satisfied that the procedure is being followed. At the Inspector's discretion, all or a percentage of the surveyor/screener's "cleared" properties may be resurveyed/screened to confirm their "cleared" status. Additionally, the Inspector will have the authority to place the surveyor/screener into additional training and/or recommend their removal from the survey/screening process.

3.3.1.2.2 Repetition of a Percentage of Survey/Screening Efforts

Since confidence in the screening/survey effort to accurately "clear" properties is essential, at least one percent of the "Not Involved" or instrument screening "Cleared" properties will be repeated each day by another screening crew or a Quality Assurance Inspection Supervisor. The justification for the sampling frequency is given in Appendix C. This will result in a sampling frequency of no less than 2% of the visual surveys or no less than 3% of instrument screenings conducted by a given crew in a day. If the repetition for a visual survey does not confirm the "cleared" status, the entire day's surveys conducted by the crew will be redone, and the survey crew will be retrained in the proper procedure. In the event that a subsequent repetition identifies a continuing



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

proper procedure, and the instrument checked for potential problems/interferences. In the event that a subsequent repetition identifies a continuing problem with a screening crew, the instrument will be rechecked. If an instrument problem is not identified, the screening crew personnel will be reassigned.

3.3.2 Assessment and Verification of Final Clearance Data

The assessment and verification of the Final Clearance data acquisition process entails oversight/review of data at two key result acquisition processes. These processes are the final clearance sample collection process, and the laboratory analysis procedures/protocols process. Each process point includes its own QA/QC indicators and each will be reviewed/verified and tracked separately.

3.3.2.1 Final Clearance Sample Collection Process

QA/QC oversight of the sample collection process will consist of the collection/analysis of process QC samples and of the inspection/review of the actual process itself. Inspection Supervisors will observe/visit at least one Final Clearance sampling event for each Final Clearance sampling team per week. The Inspection Supervisor will complete a checklist and will note items such as:

- Proper placement of sampling pumps with regard to remediated areas and required monitoring zones;
- Proper sampling pump flow rate;
- Proper temperature conditions within the property being sampled; and
- Proper field QC samples- Field Blank, Filter Media Blanks, Duplicates.
- Verify proper pump calibration.

Results from Field QC samples will be evaluated and tracked to determine if the sampling pumps are being adequately flushed between events and, if acceptable, reproducibility can be achieved. Table 3.2 summarizes these measures.

Table 3.2: Field QC Measures		
Field QC Indicator	Frequency	Objective
Field Blank	1 per property	Mercury < 0.0001 mg/m ³ <ul style="list-style-type: none">• If higher, review all results

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NICOR MERCURY
October 18,



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

problem with a survey crew, the personnel will be reassigned. If the repetition for an instrument screening does not confirm the "cleared" status, the entire day's surveys conducted by the crew will be redone, and the screening crew will be retrained in the proper procedure, and the instrument checked for potential problems/interferences. In the event that a subsequent repetition identifies a continuing problem with a screening crew, the instrument will be rechecked. If an instrument problem is not identified, the screening crew personnel will be reassigned.

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- Proper temperature conditions within the property being sampled; and
- Proper field QC samples- Field Blank, Filter Media Blanks, Duplicates.

Results from Field QC samples will be evaluated and tracked to determine if the sampling pumps are being adequately flushed between events and, if acceptable, reproducibility can be achieved. Table 3.2 summarizes these measures.

Verify proper pump calibration



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

0.01 ug/m³

avg. 0.0003 in outlet

Table 3.2: Field QC Measures

Field QC Indicator	Frequency	Objective
Field Blank	1 per property	Mercury < 0.0001 mg/m ³ • If higher, review all results for false positives • If results are positive, repeat effort
Filter Media Blank	2 per property from same lot	Mercury < RL (As above)
Duplicate	Ten percent of total samples	RPD < 40%

3.3.2.2 Laboratory Analysis Process

The laboratory results submitted from the filter samples will be reviewed/verified for both completeness and QC compliance. The result report package will be first reviewed to verify that:

- Results for all samples submitted are included,
- A case narrative is included and any QC problems are noted,
- Sample identifiers match sampling documentation,
- Sample volumes match documentation,
- Results are reported in proper units- mg/m³,
- Chain-of-Custody accompanies results,
- All QC results are included, and
- Instrument calibration information is included.

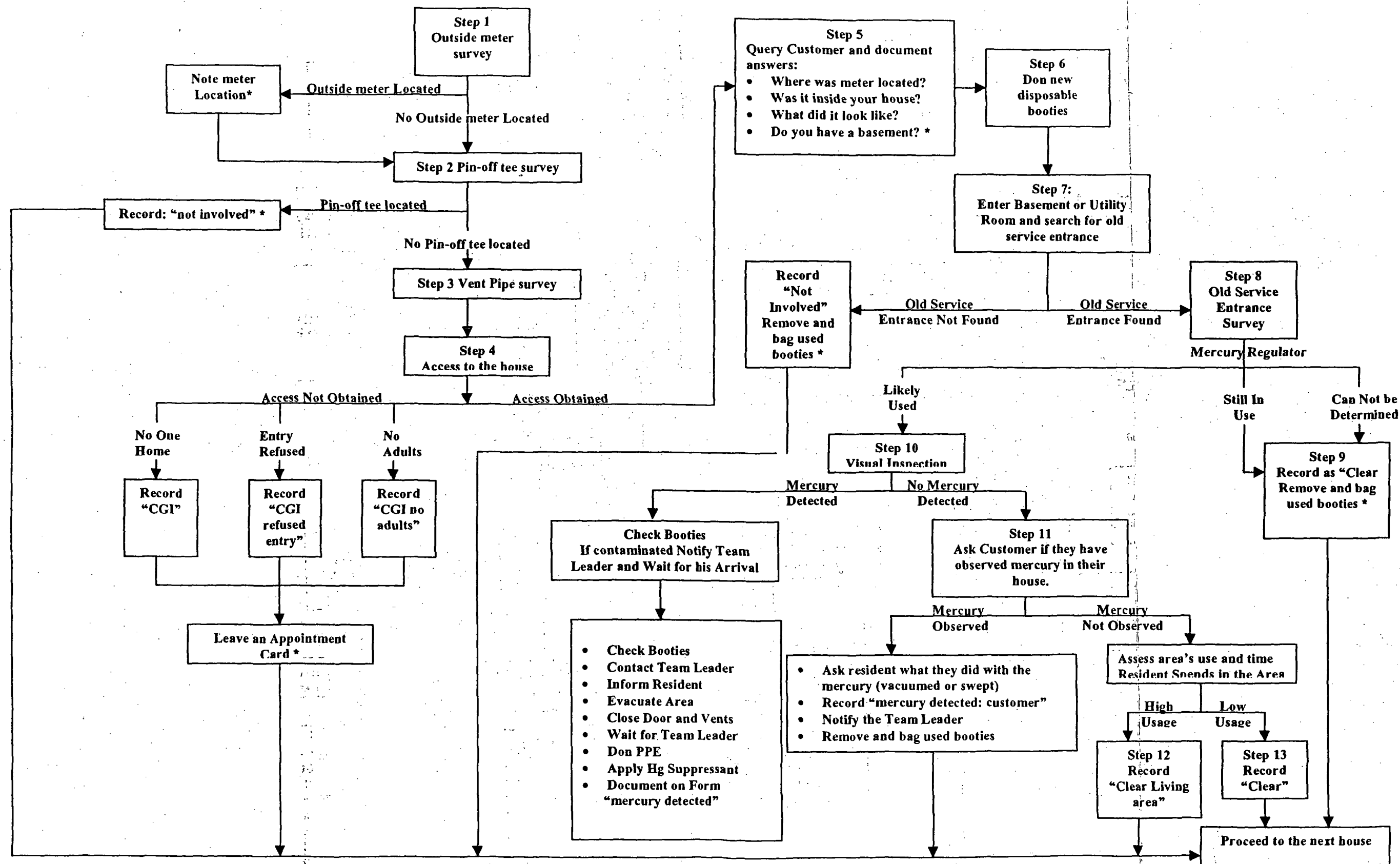
Secondly, the QC results will be reviewed for compliance with the stated acceptance limits and goals. If QC results do not meet objectives, the potential bias on the reported results will be determined and the laboratory will be contacted to review the data and/or repeat the analysis. A Data Review Memo will be attached to the report noting any QC deficiencies and its effects on the data decision-making process. If QC deficiencies are found to compromise data usability, the entire Clearance Effort will be repeated. Table 3.3 summarizes these foregoing laboratory QC measures that shall be employed.



3.0 COLLECTION AND EVALUATION OF ENVIRONMENTAL DATA

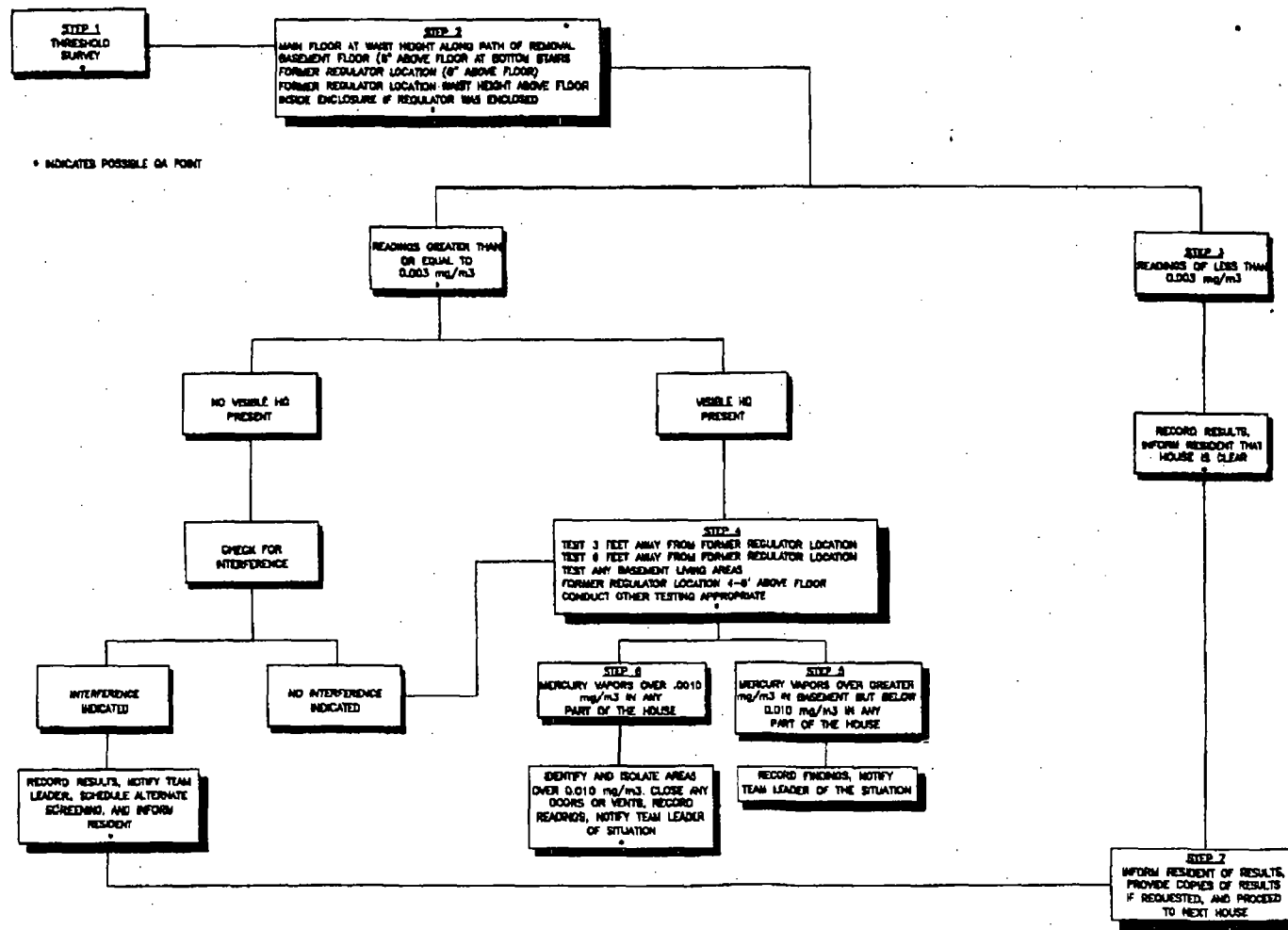
Table 3.3: Laboratory QC Measures		
QC Indicator	Acceptance Limit	Data Use Action
Instrument Blank	<2X RL	If not, review all results for false positive occurrence
Calibration check of instrument	90-110% of actual	Reject results reported from invalid curve
LCS	80-120% recovery	Recovery < 50% - Reject all results Recovery > 150% - Reject all results above action-level as biased and repeat effort
Replicate	RPD < 35%	Review all positive results for potential precision bias. Reject results for which +/- would result in opposite decision versus action-level

FIGURE 3-1 VISABLE MERCURY SCREENING FLOW CHART



* Points where QA can be performed

FIGURE 3-2 INSTRUMENT SCREENING FLOW CHART




	NICOR CHICAGO, ILLINOIS
	FIGURE 3-2 INSTRUMENT SCREENING FLOW CHART NICOR CHICAGO, ILLINOIS

FIGURE 3-3 PROPERTY CLEANUP FLOW CHART

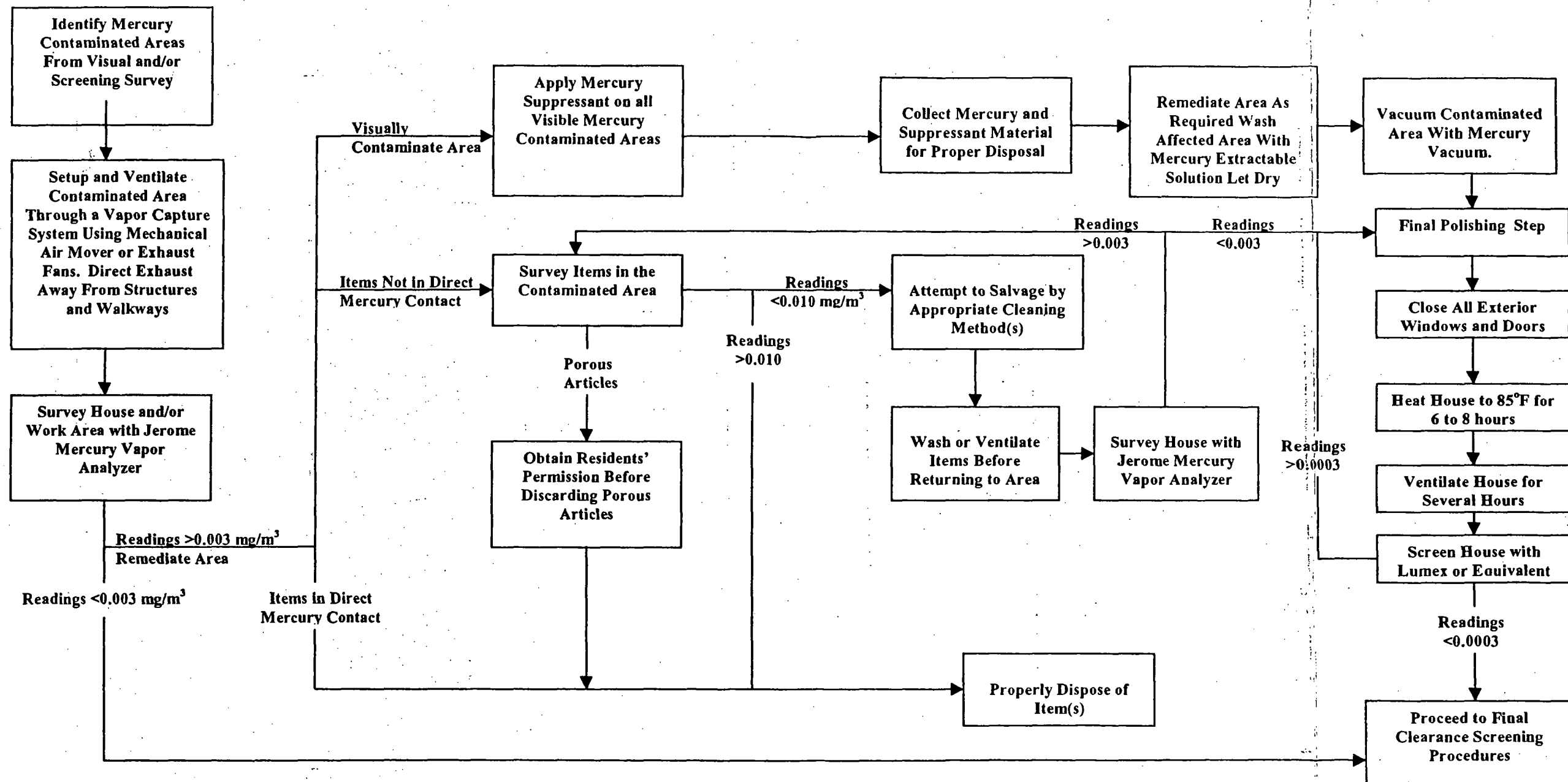
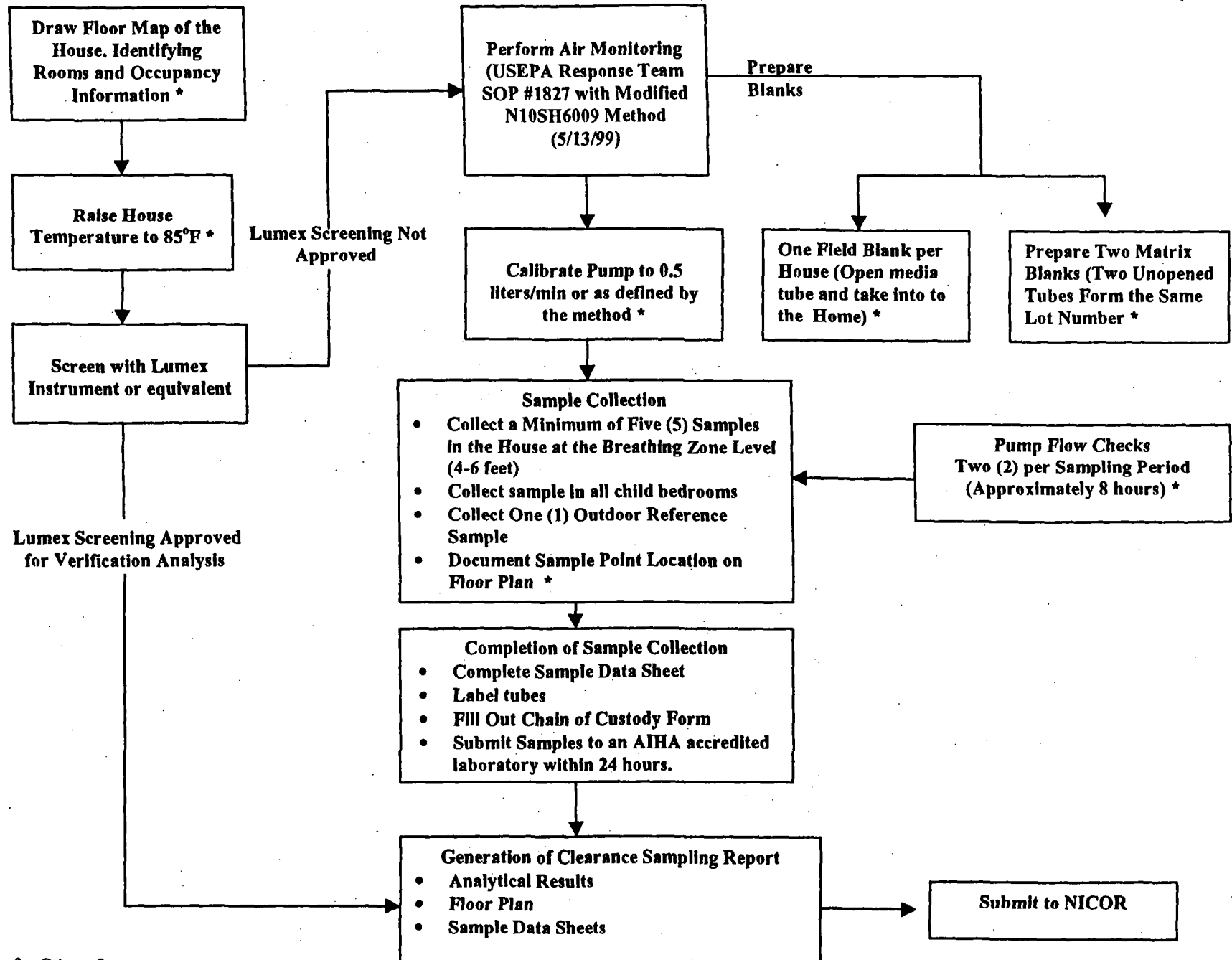


FIGURE 3-4 FINAL CLEARANCE SCREENING



* points for QA performance

N0007625

APPENDIX A

**MANUFACTURER'S
OPERATION MANUALS**

APPENDIX A

JEROME 411
MERCURY VAPOR ANALYZER
Operation Manual

July 1997

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Revision C

N0007627

JEROME 411
MERCURY VAPOR ANALYZER
OPERATION MANUAL

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THE JEROME 411 GOLD FILM MERCURY VAPOR ANALYZER

The Jerome 411 Gold Film Mercury Vapor Analyzer is designed for the easy and accurate analysis of mercury vapor in the workplace environment and for the location of mercury spills. This portable instrument will operate five hours on fully charged batteries. The 10-second SAMPLE mode provides an integrated, direct reading of mercury vapor concentration in mg/m^3 . The 1-second SURVEY mode allows quick checks to locate high concentration areas.

The microprocessor automatically rezeroes the digital meter at the start of each sample cycle and freezes the meter reading until the next sample cycle is activated, thus eliminating drift between samples.

PRINCIPLE OF OPERATION

A thin gold film, in the presence of mercury vapor, will undergo an increase in electrical resistance proportional to the mass of mercury in the sample.

Activating either the 10-second SAMPLE or 1-second SURVEY mode starts an internal pump which draws a precise volume of air over the Gold Film Sensor. The Gold Film Sensor adsorbs and integrates the mercury vapor, and the resulting signal is displayed on the digital meter.

As mercury adsorbs on the sensor, the percentage of saturation is indicated on the digital meter by pressing the SENSOR STATUS button. Approximately forty 10-second samples containing $0.1 \text{ mg}/\text{m}^3$ Hg may be taken before the sensor reaches saturation. At this point, a 15 minute heat cycle is manually activated to desorb the accumulated mercury from the sensor. An internal charcoal filter prevents contamination from the desorbed mercury.

INSTRUMENT OPERATION

DIRECTORY OF DIGITAL METER DISPLAY CODES

Meter Display	Explanation
.000	Ready to sample
.H.H.H	Film heat in progress (.H.H.H flashes)
LO BAT	Recharge batteries (see page 8)
.L.L.L	Bridge balance is below 0 (see page 4)
.8.8.8	Press SENSOR STATUS

If the digital meter displays 100, the Gold Film Sensor is saturated. No further operation is possible until a film heat is performed. Refer to page 3 for film heat procedure.

If the digital meter does not read 100, the sample was over range. Further operation is possible with samples of lower concentration, or with the use of a Dilution Module. For dilution module information call Customer Service at (800) 235-3360.

Sensor Status Button Pressed

.10	10% sensor saturation
.50	50% sensor saturation
.100	100% sensor saturation - film heat required

OPERATIONAL TEST

Before each day's use of the Jerome 411, perform the following 4 steps to verify the instrument is operational.

Procedure:

1. Press power ON.

The digital meter displays .0.0.0 (Disregard the digital meter's initial momentary readings.). Recharge or replace the battery pack if the LO BAT indicator remains on. Refer to page 8 for the procedure.

2. Perform a film heat.
Refer to page 3 for the procedure.
3. Press SENSOR STATUS.
The digital meter displays the percent of mercury saturation of the sensor. The SENSOR STATUS must be between 01 and 99 for the instrument to operate. Refer to page 4, step 6 for the adjustment procedure.
4. Press SAMPLE (10-second).
The digital meter counts up 9 seconds, as indicated by EO1 through EO9. At the end of the 10-second cycle, the digital meter displays the level of mercury present in the air.

FILM HEAT PROCEDURE

Line voltage must be between 115 and 120 VAC for the films to clean properly. (For 230 VAC models, line voltage must be between 230 and 240 VAC.)

CAUTION: Once a FILM HEAT is initiated, DO NOT interrupt the cycle.

Procedure:

1. Insert a zero air filter in the instrument's intake and tighten the intake tube nut to ensure an airtight seal.
This filter prevents mercury in the atmosphere from entering the Jerome 411.
2. Attach the line cord to the 411 and plug into a VAC outlet.
The line cord is used during a FILM HEAT to provide line voltage to the films.
3. Connect the battery charger to the 411 and plug into a VAC outlet.
This ensures completion of the FILM HEAT cycle. The battery charger supplies operating voltage to the instrument.
4. Press power ON.
NOTE: If LO BAT is ON, turn unit OFF and charge the batteries at least one hour before activating a film heat.
5. Press FILM HEAT.
The digital meter flashes .H.H.H for the duration of the 15-minute cycle.

DO NOT INTERRUPT THIS CYCLE.

Wait a minimum of 30 minutes after the cycle is complete before continuing with the next step.

6. Press SENSOR STATUS and hold down. Adjust the BRIDGE BALANCE using the trimmer tool until the digital meter reads greater than 02 and less than 06.
If the meter reads less than 02, turn the BRIDGE BALANCE counter-clockwise; if greater than 06, turn the BRIDGE BALANCE clockwise.

IMPORTANT: The BRIDGE BALANCE should be adjusted only after a FILM HEAT cycle.

7. Press power OFF.
8. Disconnect the battery charger.
9. Disconnect the line cord.
10. Remove the zero air filter.
11. The Jerome 411 is ready for sampling.

NOTE: If FILM HEAT is activated with the line cord unplugged, there is no voltage applied to the film chamber. Under these circumstances, the cycle may be discontinued by pressing the power OFF.

SAMPLING FOR MERCURY

SAMPLE 10-SECOND

Procedure:

1. Press SAMPLE (10-second).
2. Read the digital meter.
The number displayed at the end of the count is the mercury concentration in mg/m^3 . This value remains displayed until the next sample is taken. The digital meter automatically zeroes at the start of each sample.
3. Occasionally check SENSOR STATUS.
4. Press power OFF when not in use.
The Jerome 411 will operate 5 hours on a fully charged battery.

SURVEY 1-SECOND

The SURVEY 1-second mode DOES NOT provide for accurate analysis of mercury concentrations. This mode is used to assess areas of potentially high mercury concentrations. If sampling unknown mercury levels or locating spills, use this 1-second mode first.

Procedure:

1. Press SURVEY (1-second).
2. Read digital meter.
3. Occasionally check SENSOR STATUS.

The probe may be used for locating mercury vapor in hard to reach places. Plug the probe directly into the instrument's intake.

CAUTION: The Jerome 411 is intended for vapor use only. DO NOT allow the probe or the instrument's intake to come in contact with liquids, dust or other foreign material.

NOTE: Plug the Zero-Air Filter in the instrument's intake when not in use.

OPERATING ON BATTERY POWER

Battery power enables you to use the Jerome 411 as a portable instrument. If battery power is necessary for your use, please be aware of the following:

- A fully charge battery pack provides power for five (5) hours of operation
- For operation longer than five (5) hours, an extra fully-charged battery pack is needed. Refer to NOTE on page 8.
- 20 minutes of sampling remains after LO BAT is indicated.
- Complete battery recharging takes 14 hours. Refer to page 8 for the procedure. Refer to page 7 for battery maintenance.

OPERATING ON POWER SUPPLY

For stationary use, the optional Continuous Operation Power Supply Kit (COPS) is available for the Jerome 411. The COPS kit eliminates the need for the battery pack and its necessary maintenance. Installation steps follow:

Procedure:

1. Unplug the line cord.
2. Remove the two (2) side screws from the digital meter end of the instrument and open the case lid.
3. Locate the battery jacks and disconnect them.
4. Remove the battery pack from the instrument.
5. Plug the jumper assembly into the instrument battery jack.
The jumper assembly is included in the COPS kit.
6. Close the case and replace the side screws.
7. Plug the power supply into the battery charger receptacle on the rear of the Jerome 411.
When the power supply line cord is plugged into 115 VAC (or 230 VAC), the instrument is ready for use.

WARNING!!!

With the COPS jumper assembly installed in the Jerome 411, the battery charger should NOT be plugged into the charging jack. The battery charger does not supply adequate current to operate the instrument, and damage to the instrument and/or the battery charger will result.

MAINTENANCE

PREVENTIVE MAINTENANCE CALENDAR

To keep the Jerome 411 operating at peak performance, follow this maintenance schedule.

Charge batteries	After 1 month storage or at the end of a day of use	page 8
Change intake filter disc	After 20 hours of use, or as needed	page 10
Change internal filter system	After 6 months of use, or as needed	page 11
Change scrubber filter	Annually	page 11
Check instrument's calibration	After 20 hours of use, every 3 months, or as needed	page 14
Replace zero air filter*	Annually	

NOTE: Plug the zero air filter in the instrument's intake during storage.

* The zero air filter contains Resisorb mercury vapor absorbent. For safety information, see the Resisorb Material Safety Data Sheet included in this manual.

OBTAINING MAXIMUM BATTERY LIFE

There are certain inherent limitations to NiCd batteries. A major limitation is a "memory" effect that occurs if the batteries are partially discharged and then recharged repeatedly. This "memory" leads to a drastic reduction of usable battery capacity. To prevent this, periodically allow the battery pack to discharge until LO BAT appears on the digital meter. Then recharge battery pack. To obtain maximum battery life, follow these 3 steps.

1. At least once a month wait until LO BAT appears on the digital meter before recharging the battery pack.
2. Charge the battery pack when the LO BAT indicator comes on. Excessive discharge can damage the battery pack.
3. Use the plastic button guard on the power ON/OFF switch when packing the instrument in the carrying case. This will prevent the power being turned on and running down the batteries. Before storing the instrument, verify the power is OFF.

When batteries fail to hold a charge, the battery pack should be replaced. Battery life under normal usage is approximately 1 year depending on the number of charge and discharge cycles.

NOTE: Instead of recharging the batteries with the Jerome 411, a spare battery pack may be recharged with the battery charging adapter and battery charger, outside the instrument.

When the instrument indicates LO BAT, simply exchange the discharged pack with a fully charged spare for continued operation.

The discharged pack may then be connected to the adapter and charger, then recharged for the full 14 hours without putting the instrument out of service.

CHARGING BATTERIES

Procedure:

1. Press power OFF.
2. Connect the battery charger to the Jerome 411.
3. Plug the charger into a VAC outlet.
Complete battery recharging takes 14 hours.

REPLACING BATTERY PACK

Procedure:

1. Press power OFF.
2. Unplug the line cord.
3. Ensure the battery charger is disconnected from the Jerome 411.
4. Remove the two (2) side screws from the digital meter end of the instrument.
5. Open the Jerome 411 case lid.
6. Disconnect battery jacks.
7. Loosen the two (2) captive screws holding the battery pack bracket and remove the bracket.
8. Remove the old battery pack and replace with a new battery pack.

9. Replace the battery pack bracket and tighten the captive screws.

10. Reconnect the battery jacks.

11. Close the case and replace the screws.

FLOW SYSTEM

The Jerome 411's flow system is the crucial link between the sensor and the sample. For the instrument to perform correctly, the flow system must be properly maintained. This system consists of the intake assembly, internal filter system and scrubber filter.

See the following section for information on when to change filter disc and filters:

Change intake filter disc	After 20 hours of use, or as needed	page 10
Change internal filter system	After 6 months of use, or as needed	page 11
Change scrubber filter	Annually	page 11

For proper flow, the Tygon™ tubing on the filter systems must be free of crimps.

INTAKE FILTER DISC

Replace the intake filter disc after twenty (20) hours of sampling. In dusty environments the filter disc may need replacement as often as once a day. Replacement .25 diameter intake filter discs are available from Arizona Instrument Corporation (p/n 2600-3039).

Procedure:

1. Unscrew the intake from the Jerome 411.
2. Remove the old filter disc using a trimmer tool.
3. Use tweezers to insert the new filter disc. Avoid touching the new filter disc with your fingers.
4. Using your trimmer tool, seat the disc firmly against the inner ledge of the intake.
5. Screw the intake back on the Jerome 411.

INTERNAL FILTER SYSTEM

Replace the internal filter system after 6 months of use, or as needed.

Procedure:

1. Unplug the line cord.
2. Remove the two (2) side screws on the digital meter end of the instrument and open the case.
3. Carefully disconnect the Tygon tubing from the intake and from the gold film sensor (to the left side of the sensor).
4. Remove the old internal filter system* and discard using proper disposal methods.
5. Attach the new internal filter system.
Ensure the arrow on the filter is pointing in the direction of the air flow.
6. Push the filter into the mounting clips.
7. Remove any crimps in the tubing and check that tubing connections are secure.
8. Close the case and replace the screws.

* The internal filter contains Mallcosorb. For safety information, see the Mallcosorb Material Safety Data Sheet included in this manual.

SCRUBBER FILTER

The scrubber filter traps mercury released during film heat. Change this filter once a year.

CAUTION: Old filters contain mercury. For safety information, see the Mercury Material Safety Data Sheet included in this manual. Use proper disposal methods.

Procedure:

1. Unplug the line cord.
2. Remove the two (2) side screws on the digital meter end of the instrument and open the case.
3. Carefully disconnect the Tygon tubing from the gold film sensor (right side) and slide the scrubber filter* out of the mounting clip.

4. Remove the Tygon tubing from the scrubber filter.
Do not remove the Tygon tubing from the pump.
 5. Discard the old scrubber filter using proper disposal methods.
 6. Connect the Tygon tubing from the pump to the new scrubber filter.
Ensure the arrow on the scrubber filter is pointing in the direction of the air pump.
 7. Connect the remaining Tygon tubing to the new scrubber filter and connect the other end to the gold film sensor.
 8. Slide the scrubber filter into the mounting clip.
 9. Remove any crimps in the tubing and check that the tubing connections are secure.
 10. Close the case and replace the screws.
- * The scrubber filter contains Resisorb mercury vapor absorbent. For safety information, see the Resisorb Material Safety Data Sheet included in this manual.**

FUNCTIONAL TEST

If your application requires frequent verification of instrument functionality, this test will benefit you. If the test results fall within the expected range, you may assume the instrument is functioning properly. This test does not calibrate the instrument.

NOTE: The functional test should only be performed after a film heat.

011 FUNCTIONAL TEST KIT

The accessories necessary to perform this test are contained in the 011 Functional Test Kit:

- Vacuum Bottle (1)
- Stopper/thermometer assembly (1)
- Vial of Hg (1)
- Syringe assembly (1)
- Syringe needles (5)
- Septum holder assembly (1)
- Septa (20)

CAUTION: The vial and thermometer contain liquid mercury and are possible sources of mercury contamination. Follow the instructions carefully.

VACUUM BOTTLE SET-UP

Procedure:

1. Unwrap the thermometer assembly carefully.
2. Remove the cap from the vacuum bottle.
3. Remove the cap from the vial containing mercury (labeled **CAUTION: MERCURY**) and carefully pour the liquid mercury into the vacuum bottle.
Pour over a lipped container to trap any spilled mercury.
4. Install the thermometer assembly securely in the mouth of the vacuum bottle.
5. Place the vacuum bottle in a location with a stable ambient temperature.
The temperature range for the test is 18-22°C. Avoid temperature fluctuations.

CAUTION: Do not use the vacuum bottle as a portable container. If the vacuum bottle is upset or greatly agitated, mercury droplets will cling to the thermometer stem, the rubber stopper, the mouth of the vacuum bottle and the needle guide.

FUNCTIONAL TEST PROCEDURE

NOTE: The functional test should only be performed after a film heat.

1. Leave the vacuum bottle at stable room temperature for at least 2 hours.
The temperature range for the test is 18-22°C. Temperature fluctuations during the test procedure will produce erratic results.
2. Unplug the line cord and battery charger.
3. Replace the intake filter disc.
4. Replace the septum.
5. Plug the septum assembly into the instrument's intake and tighten the intake tube nut to ensure an airtight seal.
6. Attach a zero air filter to the septum assembly.
7. Press power ON.
8. Note the temperature of the vacuum bottle.
9. Inject 1cc of mercury vapor according to the syringe technique described on page 19.

NOTE: To minimize error, it is important to carefully follow this procedure.

10. Record the meter reading.
11. Repeat step 9 and 10 three times.
The last three 1cc injections should be within $\pm 5\%$ of each other. If not, refer to page 19 for proper syringe technique and repeat the procedure.
12. Refer to the Temperature Conversion Chart, page 16, for the acceptable range.
The average of the last three digital meter readings should fall within the range indicated in the chart.

IT THE AVERAGE IS WITHIN RANGE, THE JEROME 411 IS FUNCTIONING PROPERLY.

If the average is not within range, proceed to the next step.

13. Perform a film heat.
Refer to page 3. Wait 1 hour before proceeding to step 14.

14. Using the trimmer tool, adjust the BRIDGE BALANCE until the digital meter reads not less than 02 and not greater than 06.

Refer to page 4, step 6.

15. Repeat steps 5-12 of this test procedure.

If the average of the digital meter readings is still not within range, refer to page 17, Functional Test Troubleshooting.

411 TEMPERATURE CONVERSION CHART

TEMP C	DIGITAL METER RESPONSE
--------	------------------------

16	.064 to .086
----	--------------

17	.070 to .094
----	--------------

18	.076 to .094
----	--------------

19	.082 to .112
----	--------------

20	.090 to .122
----	--------------

21	.097 to .131
----	--------------

22	.105 to .143
----	--------------

23	.115 to .155
----	--------------

24	.124 to .168
----	--------------

FUNCTIONAL TEST TROUBLESHOOTING

If the proper results were not achieved during the test procedure, review the following to discover the cause:

- Ensure the battery charger and line cord are unplugged.
- Ensure the vacuum bottle temperature is stable.
- Ensure the mercury drop in the vacuum bottle is not oxidized.
- Replace a clogged, bent or contaminated syringe needle.
- If the internal tubing is crimped or blocked, straighten or replace the affected tubing.
- Ensure the instrument's intake is not blocked with foreign matter.

If none of the above conditions exist, follow these steps to determine if the flow system is contaminated:

1. Insert your zero air filter in the instrument's intake and tighten the intake tube nut to ensure an airtight seal.

2. Take 3 samples.

If the average meter reading is less than .005, there is no mercury contamination. If the average meter reading is greater than .005, proceed to step 3.

3. Remove and replace the zero air filter.

4. Take 3 samples.

If the average reading is less than .005, the old zero air filter was contaminated. If still greater than .005, proceed to step 5.

5. Change the internal filter system.

Refer to page 11.

6. Take 3 more samples.

If the average meter reading is less than .005, the internal filters were contaminated. If the average is still greater than .005, please call Customer Service at (800) 235-3360 or (602) 470-1414.

REPLACING MERCURY

An oxide coating will form on the drop of mercury and will cause lower readings in your testing. Replace your mercury on a yearly basis or when a filmy coating is evident on the surface of your mercury drop.

Procedure:

1. Carefully remove the stopper assembly from the vacuum bottle.

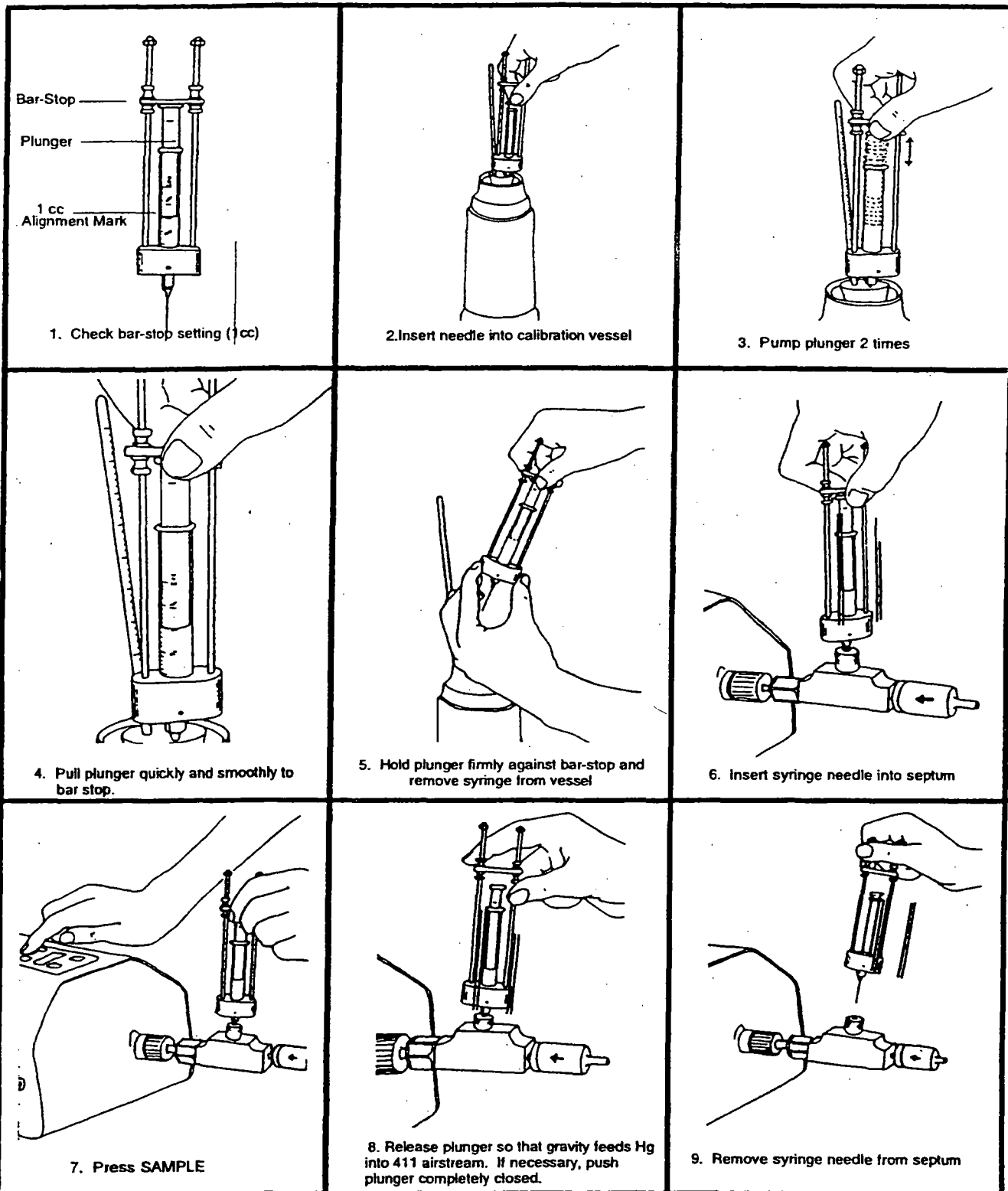
BE SURE THE NEEDLE GUIDE IS FREE OF LIQUID MERCURY.

2. Replace the oxidized mercury with approximately $\frac{1}{2}$ cc fresh mercury.

Do NOT use the syringe for measuring liquid mercury. Dispose of oxidized mercury properly.

3. Reinstall the stopper assembly.

SYRINGE TECHNIQUE TECHNICAL SPECIFICATIONS



Sensitivity	0.003 mg/m ³ Hg
Precision	5% Relative Standard Deviation @ 0.107 mg/m ³ Hg
Accuracy	±5% @ 0.107 mg/m ³ Hg
Range	0.000 to 1.999 mg/m ³ Hg
Response Time SAMPLE Mode SURVEY Mode	10 seconds 1 second
Flow Rate	750 cc/min 0.75 Liters/min = 750 CC/min
Power Requirements	115 VAC or 230 VAC 115 watts maximum
Batteries	Rechargeable nickel-cadmium
Construction	Aluminum alloy
Dimensions	6" W X 13" L X 4" H
Weight	5 pounds
Digital Meter	Liquid Crystal Display
Operating Environmental Range	0 - 40 C, non-condensing, non-explosive
Data Output	Digital, serial; Voltage levels: Logi 0 = +5V, Logic 1 = 0V Transfer rate: 150 bits/second Data string: 1 start bit (+5V) 7 data bits (ASCII format) LSB 1st 1 parity bit (always 0) 2 stop bits (0V)

ACCESSORIES & MAINTENANCE PARTS

PART # ITEM DISCRIPTION

411 Flow System

2600-3901 Internal Filter
Z2600-3930 Scrubber Filter
Z2600-3905 Zero Air filter
Z2600-3907 411 Internal Filter System (Includes Acrodisc, internal filter & Tygon tubing-assembled)
1400-3010 Tubing Adapter
2600-3039 .25 Diameter Intake Filter Disc
2500-3001 Tygon Tubing - 1/8" I.D.
2600-3015 Acrodisc - 5 micron

Calibration Equipment

2600-0030 Vacuum bottle
A2600-0902 Stopper Assembly (Includes: rubber stopper, thermometer & needle guide)
A2600-0903 Calibration Syringe Assembly (Includes: syringe, syringe holder & needle)
2600-0022 Syringe Needle
Z2600-3914 411 Septum Holder Assembly - Standard
3200-0011 Septum
A2600-0904 Vial with Hg

Replacement Parts

Z4000-0901 Battery Pack Assembly - 411
Z4000-0902 Battery Charging Adapter Assembly
1400-2002 Probe - 411
2300-0001 Trimmer Tool
4000-1003 Battery Charger - 115 VAC
6000-4003 Line Cord (411) - 115 VAC

Y411-0901 411 Accessory Kit
 Includes: battery charger (1), zero air filter (1), .25 dia. Intake filter discs (20),
 trimmer tool (1), probe (1) & tubing adapter (1)

Y411-0902 011 Functional Test Kit
 Includes: vacuum bottle (1), stopper assembly (1), vial of Hg (1), syringe
 assembly (1), syringe needles (2), 411 septum holder assembly (1) & septums (20)

Y411-0903 Maintenance Kit
 Includes: .25 dia. Intake filter discs (20), battery pack assembly (1), charging
 adapter (1), 411 internal filter system (1), scrubber filter (1), zero air filter (1) & 1'
 Tygon tubing - 1/8" I.D.

- Y411-0904 411 Carrying Case Assembly
Includes: case & die cut foam rubber. Holds: Jerome 411, 412 Dosimeter
Controller, Personal Mercury Dosimeters & accessories
- Z2600-3911 10:1 Dilution Module Assembly
- X412-0901 Personal Mercury Dosimeter
- Y411-0905 Continuous Operation Power Supply Kit (COPS) - 115 VAC

FACTORY CALIBRATION & MAINTENANCE SERVICE

Service includes instrument reconditioning & recalibration to bring to manufacturer's specifications.

Call AZI Customer Service Department for authorization and scheduling.

FACTORY CALIBRATION SERVICE

Service includes checking and adjusting instrument calibration.

Call AZI Customer Service Department for authorization and scheduling.

(800) 235-3360 or (602) 470-1414

WARRANTY

Arizona Instrument Corporation (seller) warrants to buyer that Jerome products delivered pursuant to this Agreement shall, at the time of delivery, and for a period of one (1) year thereafter (the Internal Battery Pack, where applicable, is warranted for a period of ninety [90] days only), be free from defects in material or workmanship and shall conform to seller's specifications or such other specifications as seller has agreed to in writing. Seller's obligations with respect to claims under this warranty shall be limited, at seller's option, either to the replacement of defective or non-conforming product or to an appropriate credit for the purchase price thereof subject to the provisions of seller's Warranty Policy as amended from time to time, said Policy being incorporated herein by reference.

Return products under warranty claims will be shipped to seller's plant by buyer at buyer's expense and shall be accompanied by a statement of the reason for the return and an approved Return Material Authorization Number issued by seller. Buyer remains responsible for payment for products not accepted for warranty adjustment and freight and handling costs associated therewith.

Notwithstanding the foregoing, no warranty shall be enforceable in the event that product has been subjected to environmental or stress testing by buyer or any third party without written approval of seller prior to such testing. Further, no warranty shall be enforceable if the alleged defect is found to have occurred as a result of misuse, neglect, improper installation, repair, alteration, accident, or improper return handling procedure by the buyer.

Discontinued product is warranted only for a credit or replacement at seller's option.

THE EXPRESS WARRANTIES GRANTED ABOVE SHALL EXTEND DIRECTLY TO BUYER AND NOT TO BUYER'S CUSTOMERS, AGENTS, OR REPRESENTATIVES AND, EXCEPT FOR WARRANTY OF TITLE, IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, SUCH OTHER WARRANTIES BEING SPECIFICALLY DISCLAIMED BY SELLER. IN NO EVENT SHALL EITHER PARTY'S LIABILITY FOR ANY BREACH OR ALLEGED BREACH OF THIS AGREEMENT EXCEED THE TOTAL EXTENDED PRICE OR PRICES SHOWN ON UNFILLED ORDERS, NOR SHALL EITHER PARTY BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM BREACH OR ALLEGED BREACH.

Notwithstanding the foregoing, if any product covered by order(s) placed hereunder is designated as "developmental," "prototype" or "experimental," no warranty whatsoever except a warranty of title to component materials will be applicable thereto and buyer shall indemnify seller for any claims for liability asserted seller in connection therewith.

Medical Applications: Seller's products are not designed for use in medical appliances, devices, or systems where malfunction of buyer's product can result in personal injury. Buyer's customers using or selling buyer's products for use in medical applications do so at their own risk and agree to fully indemnify buyer.

The foregoing state the entire liability of seller in connection with products supplied hereunder.

MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

MALLCOSORB

Arizona Instrument Corporation
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification

SYNONYMS: Soda lime solid; sodium hydroxide mixed with lime
FORMULA CAS NO.: 8006-28-28
MOLECULAR WEIGHT: N/A
HAZARDOUS INGREDIENTS: N/A
CHEMICAL FORMULA: N/A

Section 1 - Physical Data

APPEARANCE: White deliquescent pellets
ODOR: Odorless
BOILING POINT: No information found
MELTING POINT: No information found
VAPOR PRESSURE @ 20 C: Essentially zero
SPECIFIC GRAVITY: No information found

Section 2 - Fire and Explosion Data

FIRE: Not combustible, contact with moisture may generate heat to ignite combustibles.
EXPLOSION: Possible when in contact with incompatible materials.
FIRE HAZARD: Full protective clothing & NIOSH approved self-contained breathing apparatus.

Section 3 - Reactivity Data

STABILITY: Causes no hazardous decomposition or hazardous polymerization
INCOMPATIBILITIES: Water, steam, acids, fluorine & many organics; contact with nitro compounds cause formation of flammable hydrogen gas.

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Protective clothing & respiratory protection, scoop up spilled material, avoid dusting, neutralize traces with dilute acid.
DISPOSAL: Transfer to closed metal container & dispose of according to local, state & federal regulations. DO NOT CONTACT WITH WATER.

Section 5 - Health Hazard Information

OSHA PERMISSIBLE EXPOSURE LIMIT(PEL):

Calcium Oxide 5 mg/m³ (TWA)

Sodium Hydroxide 2 mg/m³ (TWA)

ACGIH THRESHOLD LIMIT VALUE (TLV):

Sodium Hydroxide 2 mg/m³ (TWA)

Calcium Oxide 2 mg/m³ (TWA)

EXPOSURE/HEALTH EFFECTS:

INHALATION - Upper respiratory tract damage, pneumonitis;

INGESTION - Severe mouth, throat & stomach burns, severe tissue scarring & death may result;

SKIN & EYES - Irritation or severe burns, possible blindness resulting

FIRST AID:

INHALATION - Remove to fresh air; if not breathing, give artificial respiration; if breathing is difficult, give oxygen; get medical attention immediately.

INGESTION - DO NOT INDUCE VOMITING! give large quantities of water or milk; get medical attention immediately.

SKIN & EYES - Immediately flush with water for 15 minute minimum; remove contaminated clothing.

Section 6 - Special Protection Information

Ventilation must be sufficient to meet TLV. Wear rubber gloves & eye protection.

Section 7- Storage and Special Information

Keep in tightly closed container, in cool, dry ventilated area, away from incompatible substances.

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

MALLCOSORB

Addendum to Material Safety Data Sheet

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Hazard Categories for SARA Section 311/312 Reporting

Acute Chronic Fire Pressure Reactive

X

Product or Components of Product	SARA Sect. 302 EHS		SARA 313 Sect. Chemicals		CERCLA Sec 103 RQ (lbs)	RCRA Sec. 261.33
	RQ (lbs)	TPQ (lbs)	Name List	Chemical Category		
MALLCOSORB™ Sodium hydroxide (1310-73-2) 1-10%	No	No	Yes	No	1000	No
Calcium chloride (10043-52-4)	No	No	No	No	No	No
Ethyl violet (2390-59-2)	No	No	No	No	No	No
Calcium hydroxide (1305-62-0)	No	No	No	No	No	No
Actual concentrations proprietary						

SARA Section 302 EHS RQ: Reportable quantity of extremely hazardous substance, listed at 40 CFR 355.

SARA Section 302 EHS TPO: Threshold-Planning Quantity of extremely hazardous substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 lbs.

Section 313 Chemicals: Toxic substances subject to annual release reporting requirements listed at 40 CFR 372.65.

CERCLA Sec. 103: Comprehensive Environmental Response Compensation and Liability Act (Superfund) Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center (800) 414-8802; listed at 40 CFR 302.4.

RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

MERCURY

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification:

CHEMICAL NAME: Mercury metal
TRADE NAME & SYNONYMS: Quick Silver
CHEMICAL FAMILY: Metals
FORMULA: Hg
FORMULA WEIGHT: 200.59

Section 1 - Physical Data

ODOR: Odorless
SPECIFIC GRAVITY ($H_2O = 1$): 13.54
VAPOR PRESSURE AT 20 °C (mmHg): 0.0012
BOILING POINT, 760 mm Hg (°C): 356.9
MELTING POINT (°C): -38.9

Section 2 - Fire and Explosion Data

FIRE HAZARD: Nonflammable
UNUSUAL HAZARDS: Extremely toxic vapors upon exposure to high temperatures.

Section 3 - Reactivity Data

STABILITY: Stable at room temperature
INCOMPATIBILITIES AND REACTIVITIES:
Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper, nitric acid

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Recover with suction cup equipped with a capillary tube.
DISPOSAL METHOD: Perform in compliance with all current local, state and federal regulations.

Section 5 - Health Hazard Information

EXPOSURE LIMIT

0.05mg/m³ (NIOSH/TWA)
0.100mg/m³ Ceiling (OSHA)

EXPOSURE/HEALTH EFFECTS: Coughing, bronchitis, pneumonia, tremor, insomnia, irritability, headache, fatigue, weakness, stomatitis, weight loss, GI disorder

SKIN & EYES: Can irritate skin and eyes

FIRST AID:

SKIN: Wash with water, get medical assistance.
EYES: Wash with water, get medical assistance.
INHALATION: Remove to fresh air, get medical assistance.
INGESTION: Get medical assistance.

Section 6 - Special Protection Information

Ventilation must be sufficient to meet TLV. Wear rubber gloves and eye protection.

Section 7 - Special Handling and Storing Precautions

Do NOT heat mercury unless appropriate safety precautions for highly toxic vapors have been taken. Store in sealed container.

Section 8 - Hazardous Ingredients

Mercury and Mercury vapor

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however, makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

RESISORB

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification:

PRODUCT NAME: Resisorb - Mercury Vapor
Absorbent
FORMULA CAS NO.: 00000-00-0
MOLECULAR WEIGHT: .00
CHEMICAL FORMULA: Proprietary mixture

Section 1 - Physical Data

APPEARANCE & ODOR: Black solid with
halogen-like odor
BOILING POINT: N/A
MELTING POINT: N/A
VAPOR PRESSURE: N/A
SPECIFIC GRAVITY: N/A

Section 2 - Fire and Explosion Hazard Data

FIRE: Combustible, keep away from heat, sparks,
flame.
EXPLOSION: Contact with strong oxidizers may
cause explosion.
FIRE HAZARD: Use water spray to soak, class A
extinguisher, gull protective clothing & NIOSH
approved self-contained breathing apparatus, move
exposed containers from fire area if it can be done
without risk, if not, use water to keep fire-exposed
containers cool.

Section 3 - Reactivity Data

STABILITY: Stable, no hazardous polymerization
CONDITIONS TO AVOID: Heat, flame, sources of
ignition
INCOMPATIBILITIES: Strong oxidizing agents,
nitric acid, ammonia, alkali metals, strong reducing
agents

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Protective clothing &
respiratory protection, scoop up spilled material,
avoid dusting, flush spill area with water.
DISPOSAL: Transfer to clean, dry container &
dispose of in accordance with local, state & federal
environmental regulations.

Section 5 - Health Hazard Information

EXPOSURE/HEALTH EFFECTS:

INHALATION: May cause tightness & chest pain,
coughing & difficulty in breathing.
INGESTION: May cause nausea, vomiting,
headaches.
SKIN AND EYES: Dust may irritate skin and/or
eyes.

FIRST AID:

INGESTION: get medical attention, if conscious,
immediately induce vomiting.
SKIN AND EYES: Immediately flush with water for
15 minute minimum; remove contaminated clothing.

Section 6 - Special Protection Information

Use adequate general or local ventilation to keep
fume or dust levels as low as possible. If airborne
concentration is high, use respirator or dust mask.
Wear rubber gloves & eye protection.

Section 7 - Storage and Special Information

Keep in tightly closed container, in cool, dry
ventilated area, away from heat, sparks or flame;
isolate from incompatible substances.

The information and recommendations set forth
herein are presented in good faith and believed to be
correct as of the date hereof. Arizona Instrument
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determination as to its suitability for their purposes
prior to use. In no event will Arizona Instrument
Corporation be responsible for damages of any
nature whatsoever resulting from the use of or
reliance upon this information.

MATERIAL SAFETY DATA SHEET

NICKEL CADMIUM BATTERY

MATSUSHITA BATTERY INDUSTRIAL CO
1 Matsushita-Cho
Moriguchi Osaka 570 JAPAN
EMERGENCY TELEPHONE 201-392-6703
INFORMATION TELEPHONE 714-373-7538

Product Identification:

PRODUCT NAME: Nickel Cadmium Battery
HAZARDOUS INGREDIENTS: $\text{Ni}(\text{OH})_2$, NiOOH ,
 Cd , $\text{Cd}(\text{OH})_2$, KOH or NaOH , LiOH
CHEMICAL FORMULA: NiCd

Section 1 - Physical Data

APPEARANCE & ODOR: None
BOILING POINT: Approximately 170 °C
MELTING POINT: N/A
VAPOR PRESSURE: N/A
SPECIFIC GRAVITY: 2.6

Section 2 - Fire and Explosion Data

FIRE HAZARD: Under normal charging and
discharging, no fire hazard exists.
EXPLOSION: Under normal charging and
discharging, no explosion hazard exists.

Section 3 - Reactivity Data

STABILITY: Extremely stable
INCOMPATIBILITIES: N/A

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Non-toxic in normal use
DISPOSAL METHOD: DO NOT incinerate.
Dispose of in discharged state to avoid shorting.

Section 5 - Health Hazard Information

EXPOSURE/HEALTH EFFECTS:

INHALATION: N/A
INGESTION: N/A
SKIN AND EYES: May irritate if contact is made
with the electrolyte (alkaline).

FIRST AID:

INHALATION: N/A
INGESTION: N/A
SKIN AND EYES: Immediately flush affected area
with cool water. If contact is made with the eyes or
mucous membranes, immediately flush with water
and get medical assistance.

Section 6 - Special Protection Information

No special protection required in normal usage.

Section 7 - Storing and Special Information

No special precautions required for storing.

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Arizona Instrument Corporation
Jerome 411 Mercury Vapor Analyzer Manual
Part Number: SS-101
Revision C
July 1997

If you have any questions regarding the operation of this instrument, please call our toll free number (800) 235-3360. Internationally, call (602) 470-1414 or fax (602) 470-1888.

Arizona Instrument Corporation
4114 East Wood Street
Phoenix, Arizona 85040 USA

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intl@azic.com - International
support@azic.com - Customer Support

JEROME 431-X
MERCURY VAPOR ANALYZER
Operation Manual

July, 1996

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Part Number SS-086
Doc# 6J21-0001, Rev C

N0007659

JEROME 431-X
Mercury Vapor Analyzer

Operation Manual

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VERSION ON WORKING
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FOR THOSE WHO CAN'T WAIT TO USE YOUR JEROME 431-X BEFORE READING THIS MANUAL

Remember to read the manual for added details that will optimize the results and the life of your instrument. Also refer to the manual for complete details on operation, maintenance and troubleshooting or if your application requires use of dosimeters, special voltage inputs or data output.

The Jerome 431-X is easy to operate and ready for use upon receipt from the factory. Follow these brief steps to use your instrument.

1. Remove the instrument from the packing material. Check for any damage and confirm receipt of all parts on your packing list. Contact Arizona Instrument Customer Service at 800-235-3360 if you have any questions.
2. Press the ON button. In less than one second the display should read .000. Note that a LO BATT message appears briefly in the upper left corner. (If the LO BATT light persists, it is necessary to charge the battery. See page 10 for details.)
3. Check the voltage setting (110 or 220 VAC) on the back of the instrument. Ensure that it is set to the correct voltage. (If the voltage must be changed, turn the knob. However, it may also be necessary to change the frequency setting; see page 16 for details.)
4. Perform a sensor regeneration by following these steps:
 - ! Plug the line cord into the instrument using the plug in the back and to an AC power outlet.
 - ! Power the instrument ON and press the REGEN button. The instrument will begin a 10 minute regeneration cycle, indicated by .H.H.H flashing on the display. **Do not interrupt this cycle.** (For a complete description of this process, see page 6.) If any error message, such as .H.L.P or .L.L.L appears on the display, see the Troubleshooting section on page 19.
 - ! Adjust the sensor zero by pressing the ZERO button and turning the zero adjust screw located under the handle. Adjust until the display reads 0.
5. The instrument is now ready to sample. Note that as the instrument measures mercury, the ZERO will display H. **Do not adjust the ZERO after the instrument has measured mercury and before the next regeneration.** (Occasionally the ZERO may drop to L (for low) between the initial zeroing and the first sample. It is OK to readjust the ZERO if the instrument has not measured mercury.)

6. The instrument is designed for work space air monitoring. Press the SAMPLE button to start a 10 second sampling cycle. **DO NOT allow the probe or the instrument's intake to come in contact with liquids. Note that the instrument is not explosion proof.**
7. After the day's survey, again perform a sensor regeneration. When complete, store the instrument with the zero air filter in the intake.

Call AZI Customer Service, or your Technical Sales Representative, at 1-800-235-3360 or 1-602-470-1414 if you have any questions

THE JEROME 431-X GOLD FILM MERCURY VAPOR ANALYZER

1 INTRODUCTION

The Jerome 431-X Gold Film Mercury Vapor Analyzer is designed for the easy and accurate analysis of mercury vapor in the workplace environment and for the location of mercury spills. The 431-X is easy to operate and has few maintenance requirements however, please take a moment to read this manual before attempting operation.

The Jerome 431-X is an ambient air analyzer with a range of 0.001 to 0.999 milligrams per cubic meter (mg/m^3 Hg). If you have any questions about your application or operation, please call AZI Customer Service at (800) 235-3360 for assistance.

Features of the 431-X, include:

- ! Automatic sensor regeneration when equipped with the communications option and used with the Jérôme Communication Interface Software (JCI) program and the Jerome data logger.
- ! Regulated film heat voltage during sensor regeneration. This allows the sensor to clean properly with voltages from 100-130 VAC (or 200-260 VAC).
- ! Survey mode can be locked in.
- ! DIP switch setting can change the digital meter readings from mm^3 Hg to nanograms (ng) of Hg (see page 17).

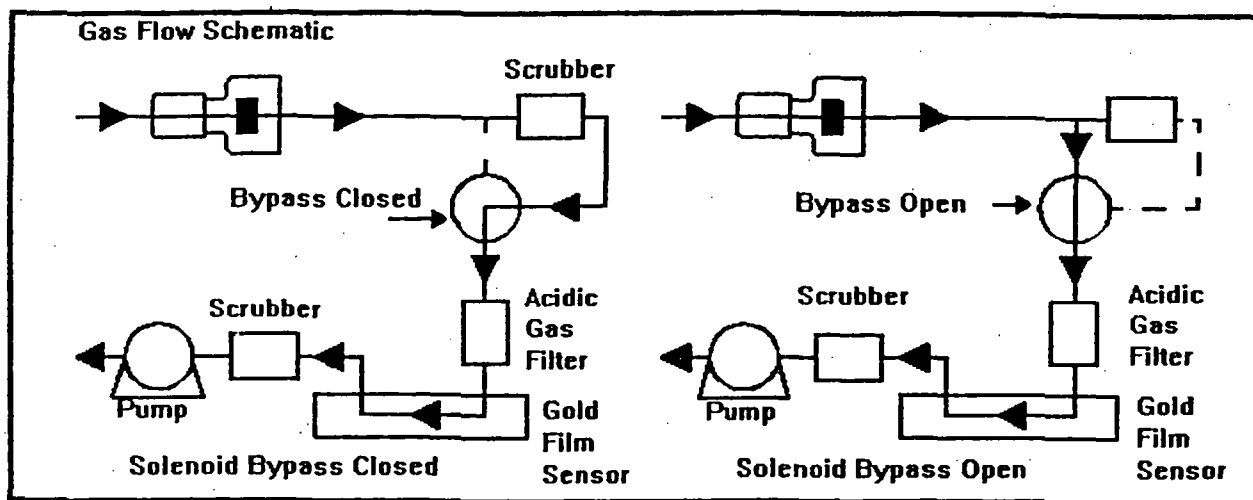
The Jerome 431-X can be operated from 100-130 or 200-260 VAC. To change the default voltage range, refer to Setting the Input Voltage, page 16.

CAUTION: The Jerome 431-X is intended for vapor use only. **DO NOT** allow the probe or the instrument's intake to come in contact with liquids, dust or other foreign material.

2 PRINCIPLE OF OPERATION

Mercury is unique in its ability to alter the resistance of a gold film. The 431-X sensor consists of two thin gold films, a reference and a sensor, configured in a Wheatstone Bridge Circuit, which detects very small changes in electrical resistance. The reference film is sealed and not exposed to mercury. The sensor film is exposed to mercury resulting in resistance changes, which are measured by the circuit. A microprocessor computes the concentration and displays the results.

Activating the SAMPLE mode starts an internal pump which draws air through a scrubber filter and into the flow system. After 2 seconds, the sample solenoid bypass opens, closing off the scrubber filter from the flow system. The sample air passes through a filter (removing any acidic gases which interfere with the sensor's response to mercury) and is drawn over the gold film sensor. The sensor adsorbs and integrates the mercury vapor. Nine seconds after starting, the sample solenoid bypass closes and the remainder of the sample is drawn through the scrubber filter and the flow system. The measured concentration is then displayed on the digital meter in milligrams per cubic meter (mg/m^3) of mercury. An internal DIP switch can be used to change the digital meter display from mg/m^3 to nanograms of mercury (see page 17).



The instrument's microprocessor automatically rezeroes the digital meter at the start of each sample cycle and retains the meter reading until the next sample cycle begins, thus eliminating drift between samples.

During the sample cycle, bars on the digital meter represent the percentage of sensor saturation. Approximately sixty-five samples containing $0.1 \text{ mg}/\text{m}^3 \text{ Hg}$ may be taken before the sensor reaches saturation. After absorbing approximately 500 nanograms of mercury, the sensor becomes saturated and needs to be cleaned. This is accomplished by a manually

activated 10 minute heat cycle, or sensor regeneration which burns the mercury from the sensor. This mercury is absorbed on internal filters to prevent any external contamination. The solenoid bypass closes during the sensor regeneration cycle, causing the air to pass through the scrubber filter, providing clean air for the regeneration process. The flow system's final scrubber prevents contamination to the atmosphere from the desorbed mercury.

After a sensor regeneration, it is necessary to bring the two gold films back to a similar resistance. The ZERO button, along with the ZERO ADJUST potentiometer, are used to reset the sensor's reference film and sensor film to the same baseline. The sensor may exhibit some low level thermal drift after the regeneration cycle, due to heat generated during sensor regeneration. To ensure maximum sample accuracy, wait 30 minutes after a regeneration and then check the ZERO adjustment. If the display reads 0 when the ZERO button is pressed, the adjustment has been accomplished. If the display reads H or L, simply turn the ZERO ADJUST pot with the trimmer tool or small screwdriver to complete the adjustment.

Only adjust the ZERO pot after a regeneration. It is not necessary to rezero between samples since the instrument automatically erases the previous reading. If the ZERO ADJUST pot is manually turned between samples, the results will be slightly lower than the actual concentration. However, this is not a permanent problem and is corrected with a sensor regeneration.

3 INSTRUMENT OPERATION

3.1 DIGITAL METER DISPLAY CODES

METER DISPLAY	EXPLANATION
000	Ready to sample
.000	Lack of mercury reading
00.0	Lack of mercury reading, display in nanograms (see page 17)
.8.8.8	Perform sensor regeneration (refer to page 6)
.H.H.H	Sensor regeneration in progress (.H.H.H flashes)
.L.L.L	Perform re-zero (refer to page 6)
.P.P.P	Power cord required or low line power, <100 VAC (or 200 VAC)(see page 17, Changing the Fuse, if .P.P.P remains on after the cord is connected.)
.H.L.P	High line power, greater than 130 VAC (or 260 VAC)
.LO BAT	Recharge batteries (refer to page 10)
.E.E.E	Same as LO BAT, automatically shuts off
.HL	High level, sample exceeded maximum sample limit (.999)
DURING SAMPLING	
-	0-25% sensor saturation
.-	25-50% sensor saturation
.-.	50-75% sensor saturation
.-.-	75-100% sensor saturation
DURING SAMPLING	USING THE SURVEY MODE
-	Survey sampling (minus sign flashes continuously)
WHEN ZERO IS DEPRESSED	Adjust to 0 <u>only</u> after sensor regeneration. It is normal for the display to read H after sampling has started.
0	Zero, ready to sample
H	High, turn Zero pot counterclockwise
L	Low, turn Zero pot clockwise

3.2 DAILY OPERATIONS

Before each day's use of the Jerome 431-X, perform the following four steps to verify proper instrument operation:

PROCEDURE:

- ! Press the power ON button.

The digital meter displays 000. (Disregard the digital meter's initial momentary reading.) Recharge or replace the battery pack if the LO BAT indicator REMAINS ON. Refer to pages 10 and/or 15 for the procedure.

To ensure the instrument's electronics have stabilized, allow a 1 minute warm up before beginning the next step.

- ! Perform a sensor regeneration. Refer to page 6 for the procedure. Thirty minutes after sensor regeneration is complete, rezero the instrument.

NOTE: For maximum accuracy, such as when testing with the Functional Test Kit, wait thirty minutes after the sensor regeneration cycle to rezero the unit. For emergency response, such as for spill cleanup, the unit can be rezeroed immediately after sensor regeneration

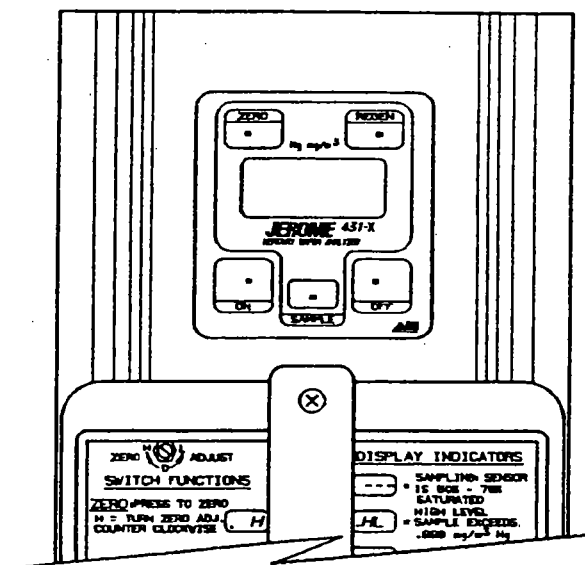
- ! Press the SAMPLE button.

During the sample cycle, the digital meter displays a bar (-) which indicates the amount of sensor saturation.

- ! At the end of the 12 second cycle, read the digital meter.

The number shown on the digital meter is the mercury concentration in mg/m^3 . This value remains on the display until the next sample is taken. The digital meter automatically zeroes at the start of each sample.

- ! At the end of each day's use perform a sensor regeneration. **DO NOT ALLOW MERCURY CONTAMINATION TO STAY ON FILM OVERNIGHT.**



3.3 SENSOR REGENERATION PROCEDURE

A sensor regeneration is needed to clear the 431-X sensor of any accumulated mercury. This simple procedure should be done:

- At the beginning of the day on which the instrument is to be used.
- During the mercury survey, if the sensor becomes saturated.
- At the end of the day's survey, before storage.

See the Principles section on page 2 for more details on the gold film sensor and the sensor regeneration.

AC power must be between 100-130 VAC or 200-260 VAC for the sensor to clean properly. If AC power is not between these limits, an .P.P.P or .H.L.P may appear in the display (see page 4). Refer to page 16 for voltage and frequency settings.

CAUTION: Once a sensor regeneration is initiated, **DO NOT** interrupt the cycle.

PROCEDURE:

- ! Attach the power cord to the 431-X and plug it into AC power. AC power is required to thermally regenerate the sensor.
- ! Press the power ON button.
- ! Press the REGEN button.

The digital meter flashes .H.H.H for the duration of the 10 minute cycle and displays .0.0.0 when the cycle is completed.

DO NOT INTERRUPT THIS CYCLE. Wait until the cycle is completed before continuing with the next step.

NOTE: The digital meter will read .P.P.P after REGEN is activated if the power cord is not plugged in or if the instrument's fuse needs replacing. Plug in the power cord, or if necessary, replace the fuse according to the procedure on page 17.

- ! While pressing the ZERO button, turn the ZERO ADJUST potentiometer using the trimmer tool until the digital meter reads 0.

*If the meter reads H, turn the ZERO ADJUST counter-clockwise;
If the meter reads L, turn the ZERO ADJUST clockwise.*

See the illustration on page 5 for the location of the ZERO ADJUST potentiometer.

NOTE: A minimum 30 minute wait after the sensor regeneration cycle is complete ensures maximum sample accuracy. The unit can be used immediately following the sensor regeneration if necessary. When the sensor regeneration is complete, press ZERO and adjust the ZERO ADJUST pot until 0 appears on the display. Install the zero air filter in the intake and take several samples or lock the instrument into survey mode (see page 9). After approximately one minute, stop sampling and check the ZERO. Adjust to 0. Repeat sampling through the zero air filter until sensor remains on 0.

NOTE: Depending upon internal configuration, a number between 00 and 100 may appear on the display, instead of H, L, or O when zero is pressed. See Internal Dip Switch Settings, page 16, for details. **IMPORTANT: Do not turn the ZERO ADJUST potentiometer between samples.** Turn the ZERO ADJUST only after a sensor regeneration cycle otherwise invalid readings will result.

! Press the power OFF button and disconnect the power cord.

! The Jerome 431-X is ready for sampling.

3.4 SAMPLE MODE

This mode, used for standard operation, produces optimum accuracy (+/- 5% at 0.100 mg/m³ Hg) with the Jerome 431-X.

PROCEDURE:

! Press the power ON button.

The digital meter displays 000. If the unit is set to display in ng, the digital meter displays 00.0. (Disregard the digital meter's initial momentary readings.) Recharge or replace the battery pack if the LO BAT indicator REMAINS ON. Refer to pages 10 and/or 15 for the procedure.

To ensure the instrument's electronics have stabilized, allow a 1 minute warm up before beginning the next step.

! Press the SAMPLE button.

During the sampling cycle, the bar (or bars) shown on the digital display indicate the current percentage of sensor saturation. (Refer to Meter Display Codes, page 4, for code descriptions.)

NOTE: *The bar (or bars) flash after 2 seconds and again after an additional 7 seconds. This flashing signals the opening and closing of the solenoid sample bypass. (See the Principles of Operation on page 2 for details.)*

! At the end of the 12 second cycle, read the digital meter.

The number shown on the digital meter is the mercury concentration in mg/m³ (or ng). This value remains displayed until the next sample is taken. The digital meter automatically zeroes at the start of each sample.

When the sensor is completely saturated, the digital meter displays .8.8.8 instead of a value. No further operation is possible until a sensor regeneration is performed. (Refer to page 6 for the Sensor Regeneration procedure.)

! Press the power OFF button when not in use. Install the zero air filter in the instrument intake during storage.

SAMPLING NOTES:

The Jerome 431-X operates a minimum of 6 hours on a fully charged battery.

Use the probe (AZI P/N1400-2002) to locate mercury vapor in hard to reach places. Plug the probe directly into the instrument's intake.

CAUTION: The Jerome 431-X is intended for vapor use only. **DO NOT** allow the probe or the instrument's intake to come in contact with liquids, dust or other foreign material. Moisture or liquids drawn into the instrument can damage the sensor and flow system.

3.5 SURVEY MODE

The survey mode takes samples every 3 seconds automatically. Use this mode to locate mercury spills or to assess areas of potentially high mercury concentrations. Sampling in the survey mode is not as accurate. Due to the decreased sample volume, the accuracy of the instrument is reduced to +/- 20% @ .100 mg/m³.

PROCEDURE:

! Press the power ON button.

The digital meter displays 000. If the unit is set to display in ng, the digital meter displays 00.0. (Disregard the digital meter's initial momentary readings.) Recharge or replace the battery pack if the LO BAT indicator REMAINS ON. Refer to pages 10 and/or 15 for the procedure.

To ensure the instrument's electronics have stabilized, allow a 1 minute warm up before beginning the next step.

! Press and hold the SAMPLE button.

The instrument takes a normal 12 second sample, displays the concentration at the end of the cycle and then goes into the survey mode sampling every 3 seconds. The display flashes the measured concentrations at the end of each 3 second sample cycle.

! When you are finished surveying, release the SAMPLE button.

The final survey value remains displayed until the next sample is taken.

NOTE: *Approximately 65 samples at .1 mg/m³ may be taken before a sensor regeneration is required.*

! To lock the instrument in a survey mode, follow the first two steps. Hold the SAMPLE button down until the sensor status indicator bar(s) "_" begins flashing on the display. Press the ZERO button, then release the SAMPLE button. The pump should continue to run and the display should update every 3 seconds.

The instrument remains in the survey mode until one of the following occurs:

- The sensor is saturated
- A LO BAT (low battery) signal is encountered
- An HL (high mercury level) is encountered
- The instrument is turned OFF.

! Press the power OFF button when not in use.

3.6 OPERATING ON AC POWER OR GENERATOR

For stationary use, the 431-X may be operated on AC power. Operating the instrument only on AC power eliminates the need for the battery pack and its necessary maintenance. If preferred, the battery may be unplugged or removed completely.

When using a generator to power the Jerome 431-X, it is important that the generator is capable of maintaining a constant voltage output. **This is especially true during the sensor regeneration.** Use a high quality line conditioner or voltage regulator to prevent damage to the electronic components and the sensitive gold film sensor.

3.7 OPERATING ON INTERNAL BATTERY POWER

Battery power allows use of the Jerome 431-X as a portable instrument. If battery power is necessary for use, please be aware of the following:

- ! A fully charged battery pack (AZI P/N 2400-0907) provides power for a minimum of 6 hours of operation.
- ! For operating more than 6 hours, an extra fully charged battery pack is needed.
- ! Complete battery recharging takes 14 hours. Refer to page 10, Charging Batteries for the procedure.
- ! The 431-X use a rechargeable NiCad battery. Dispose of properly when replaced.
- ! **External battery power:** A special version of the Jerome 431-X is available that can be operated from a secondary DC source, such as a battery used in conjunction with solar panels. Contact AZI for additional information.

3.8 CHARGING BATTERIES

PROCEDURE:

- ! Press the power OFF button.
- ! Attach the power cord to the 431-X and plug it into AC power.

Complete battery recharging takes 14 hours.

The 431-X contains a trickle charger so it may be continually plugged into an AC power source without damaging the battery pack.

NOTE: To charge the batteries outside of the instrument, use the IDC Battery Charger (AZI P/N 4000-1011, for 115 VAC, P/N 4000-1012, for 230 VAC).

3.9 OBTAINING MAXIMUM BATTERY LIFE

There are certain inherent limitations to NiCad (Nickel Cadmium) batteries. The primary limitation is a memory effect that occurs when the batteries are partially discharged and then recharged, repeatedly. This memory leads to a drastic reduction in the usable battery life. To prevent this memory effect, periodically allow the battery pack to discharge completely, then recharge the battery pack.

For maximum battery life, follow these 3 steps:

- ! At least once a month wait until LO BAT appears on the digital meter before recharging the battery pack.
- ! Charge the battery pack when the LO BAT indicator comes on. Excessive discharge can damage the battery pack.
- ! Before storing the instrument verify the power is OFF.

When batteries fail to hold a charge, the battery pack should be replaced. Battery life under normal usage is approximately 1 year, depending on the number of charge and discharge cycles.

4 MAINTENANCE

4.1 PREVENTIVE MAINTENANCE CALENDAR

To keep the Jerome 431-X operating at peak performance, follow the maintenance schedule below. Use this schedule as a guideline only, as maintenance is more a function of application and amount of use, rather than time.

MAINTAINED PART/COMPONENT	MAINTENANCE CYCLE	REFER TO PAGE
Charge batteries	At least once per month, after 1 month's storage, or when LO BAT appears	page 10
Change .25mm fritware	Weekly or as needed	page 13
Change internal filters*	After 6 months of use or as needed.	page 14
Replace zero air filter*	Annually	page 14
Factory calibration	Annually	page 18
Calibration check	Monthly or as needed	Appendix A, page 37
Replace batteries	Annually or as needed The battery pack contains NiCad batteries. Dispose of properly.	page 15

NOTE: Install the zero air filter into the instrument's intake during storage.

*C/M filters contain Mallcosorb™, Scrubber filters and zero air filters contain Resisorb™. For safety information, see the Material Safety Data Sheets included in this manual starting on page 29. Dispose of all filters properly.

4.2 FLOW SYSTEM

The Jerome 431-X's flow system is the crucial link between the sensor and the sample. For the instrument to perform correctly, the flow system must be properly maintained. The user maintainable components of this system are the intake filter (.25 mm fritware), a C/M filter, two scrubber filters and connecting tubing.

Check the Preventive Maintenance Calendar, page 12, for a suggested schedule for changing filter disc and filters. The Tygon™ tubing in the system must be free of crimps for proper flow.

431-X Flow System

Part #	Part
Z2600-3930	Scrubber Filter
Z2600-3928	C/M Filter
Z2600-3905	Zero Air Filter
1400-3010	Tubing Adapter
2600-3039	.25mm Fritware
2500-3001	Tygon™ Tubing - 1/8" I.D. (1')
1400-3009	Intake Nozzle
PS-151	Tube Nut

4.2.1 .25MM FRITWARE

Replace the .25mm fritware once a week. In dusty environments, the fritware may need replacement as often as once a day. Replacement .25mm fritware are available from AZI, Customer Service (see Accessories & Maintenance Parts, page 27).

PROCEDURE:

- ! Unscrew and remove the intake from the Jerome 431-X.
- ! Push the old fritware disc out using your trimmer tool.
- ! Use tweezers to insert the new fritware.

Avoid touching the new fritware disc with fingers.

- ! Use the blunt end of the trimmer tool to seat the fritware disc firmly against the inner ledge of the intake.
- ! Screw the intake back on the Jerome 431-X.

CAUTION: The stem coming from the instrument onto which the outer intake housing is attached must be securely held in place. If loose, the tubing inside the instrument can become twisted when the intake housing is replaced. It may be necessary to open the instrument and tighten the hold-down nuts inside the instrument. Call AZI Customer Service with questions.

4.2.2 INTERNAL FILTERS

Replace the internal filters* (one C/M filter and two scrubber filters) after six (6) months of use, or as needed. (See Troubleshooting section, page 19.)

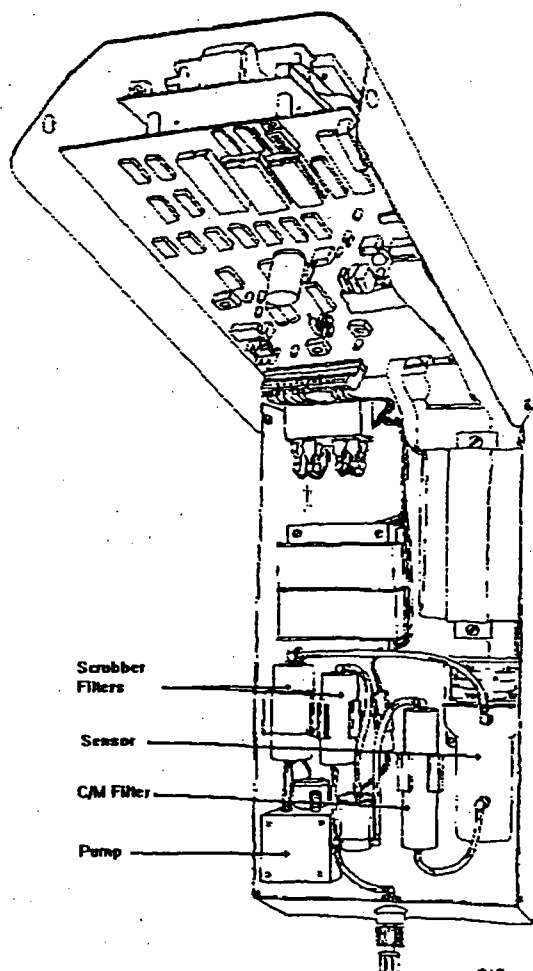
PROCEDURE:

- ! Press the power OFF button and unplug the power cord.
- ! Remove the 2 side screws from the intake end of the instrument and open the case.
- ! Carefully disconnect the Tygon™ tubing from both ends of the filters and discard the old filters.

CAUTION: Old filters, especially the scrubber filter may contain mercury. C/M filters contain Mallcosorb™ and scrubber filters contain Resisorb™. They may contain trace amounts of mercury. For safety information see the Material Safety Data Sheets on page 29. Use proper disposal methods.

- ! Connect the new filters to the Tygon™ tubing, ensuring all filter nipples point toward the intake and elbows point according to the illustration.

Push the Tygon™ as far as it will go onto the filter fittings.

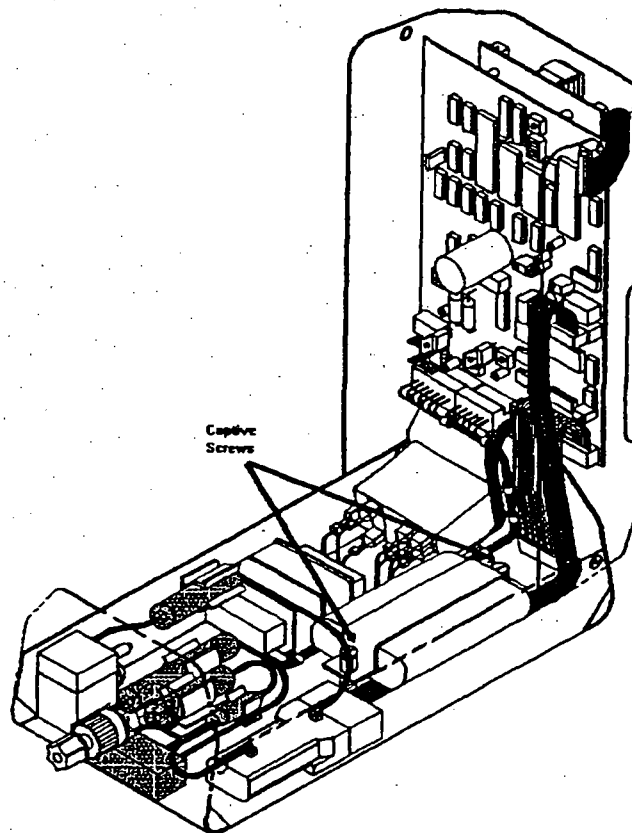


- ! Push the filters into the mounting clips.
- ! Remove any crimps in the tubing and ensure that tubing connections are secure.
- ! Close the case and replace the screws.
- ! Dispose of all filters in accordance with state and federal regulations.

4.2.3 REPLACING BATTERY PACK

PROCEDURE:

- ! Press the power OFF button.
- ! Unplug the power cord.
- ! Remove the 2 side screws from the intake end of the instrument and open the case lid.
- ! Disconnect the battery connector from the board.
- ! Loosen the 2 captive screws holding the battery bracket and remove the bracket.
- ! Remove the old battery pack and replace with a new battery pack.
- ! Replace the battery bracket and tighten the captive screws.
- ! Connect the new battery connector to the board.
- ! Close the case and replace the screws.
- ! Dispose of the old NiCad battery properly.
- ! Dispose of old nickel cadmium (NiCad) battery in accordance with state and federal regulations.



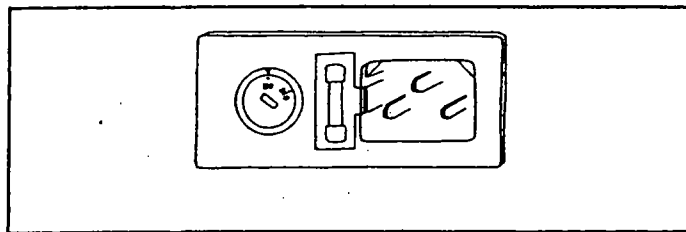
5 INTERNAL DIP SWITCH SETTINGS

5.1 SETTING THE INPUT VOLTAGE

This instrument has been factory set and calibrated to use the requested power setting (either 110 VAC or 220 VAC). The voltage setting is, however, easily changed to use either 110 VAC or 220 VAC.

PROCEDURE:

- ! Ensure the instrument is turned OFF and unplugged.
- ! Locate the power receptacle on the rear of the instrument.
- ! Insert a small screwdriver in the voltage selection slot and turn the selector until the arrow points toward your setting choice and a click is heard.



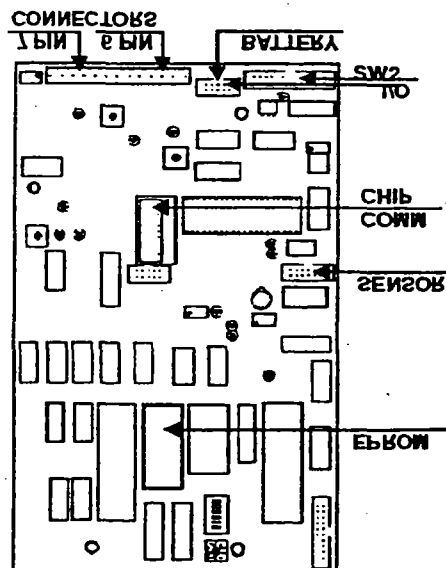
5.2 SETTING THE INPUT CYCLES

The 431-X has been set to the desired electric cycle, either 50 or 60Hz. Proper cycle setting is necessary to ensure a proper sensor regeneration.

PROCEDURE:

- ! Open the instrument lid.
- ! Locate SW2 at the top of the main circuit board (see figure, page 14)
- ! Set the SW2 switch to the appropriate cycle (Hz).

SW#2	60Hz	50Hz
Dip switch #1	OFF	OFF
Dip switch #6	OFF	ON



5.3 DISPLAYING NANOGRAMS OR MILLIGRAMS/CUBIC METER

The instrument is factory set to display mg/m^3 (milligrams per cubic meter) Hg (.XXX). For some applications, including dosimeter analysis, the instrument's display can be converted to display nanograms.

PROCEDURE:

- ! Turn the instrument off. Remove the two screws near the front of the instrument and open the lid.
- ! Locate SW2 (see diagram, page 16).
- ! Switch dip switch # 2 to OFF for nanogram display.

5.4 CHANGING THE FUSE



If the instrument display reads .P.P.P when the instrument is connected to AC power or when REGEN is pressed, or if the battery will not charge, the fuse may need to be replaced. The AC line power could also be less than 100 VAC (220 VAC). Check the fuse or the AC line power with a voltage meter.

Fuse Replacement:

PROCEDURE:

- ! Locate the power receptacle on the rear of the instrument.
- ! Insert a small screwdriver in the slot (see figure above) and gently slide the fuse compartment out.
- ! Remove and discard the fuse held in the open sided clip and replace it with the spare fuse held in the boxed spare fuse compartment.
- ! Replace the fuse compartment in the power receptacle.
- ! Replace the spare fuse with another 1A 250V Fast-Blo fuse (AZI P/N 5100-1012).

6 CALIBRATION

The Jerome 431-X's gold film sensor is inherently stable and does not require frequent calibration. The interval between calibrations depends upon the application and frequency of use; however, the recommended minimum or maximum interval is every 12 months.

The Jerome 431-X has been factory calibrated using NIST traceable permeation tubes. These permeation tubes have a rated accuracy of $\pm 2\%$. In order to calibrate the Jerome 431-X, a sophisticated calibration system is required that ensures stability of the calibration gas source, eliminates any pressure in the calibration gas stream and controls the temperature of the calibration environment. Calibration also requires special proprietary software.

We strongly recommend you take advantage of our calibration and maintenance service at Arizona Instrument. Call Customer Service at 800-235-3360 OR 602-470-1414 to arrange re-calibration. A certificate of calibration is issued from AZI when your instrument is factory calibrated.

6.1 VERIFICATION OF CALIBRATION AND QUALITY CONTROL

The Functional Test Kit (AZI P/N 4431-0902) is used to determine if your instrument is within calibration tolerances between recommended annual factory calibrations. It allows you to have complete confidence in the sample results. This test verifies proper instrument operation through the introduction of a known mass of mercury into the Jerome analyzer.

If your application requires frequent verification of instrument function, this test demonstrates the unit's operation, calibration, and function. Recording Functional Test Kit results in an instrument log provides a quality control/quality assurance record of instrument function between regular calibrations. If test results fall within the expected range, you may assume the instrument is functioning correctly. **THIS TEST DOES NOT CALIBRATE THE INSTRUMENT.**

See page 37 in Appendix A, for complete Functional Test Kit procedures.

To order the kit, contact AZI Customer Service at 800-235-3360 or 602-470-1414.

7 431-X TROUBLESHOOTING

Symptom	Possible Cause	Solution
Power Problems		
Unit does not turn ON. LCD displays 000 when connected to power cord and ON button is pressed.	Dead battery	Recharge battery (minimum 14 hours) refer to page 10. Replace battery, refer to page 15.
Unit does not turn on when connected to AC power cord.	Fuse Insufficient power	Replace fuse, refer to page 17 . Be sure there is power to the AC outlet using a volt meter.
Regeneration & zero problems		
LCD displays .8.8.8.	Sensor saturated	Do not attempt to rezero. Unit must be regenerated. See page 6 for information.
LCD displays .L.L.L when taking first sample.	Changes in temperature	Readjust zero pot. See page 5 for information .
LCD displays H at finish of sensor regeneration	Internal contamination may redeposit mercury from flow system onto gold film sensor.	Remove and replace intake filter disk, Tygon™ tubing and internal C/M filter. Check tubing for kinks or crimps. Repeat regeneration cycle. See page 6 for information.

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Symptom	Possible Cause	Solution
Zero adjust pot cannot be adjusted to 0	Pot not turned sufficiently	Turn zero adjust up to 20 times to reach the end. Pot will "click" softly.
Display still unchanged	Sensor may be ruptured or pot may be broken	Turn pot slowly in opposite direction till display reads 0. If still unchanged, call AZI Customer Service.

Sampling Problems

Air flow is restricted during the sensor regeneration cycle, causing possible permanent damage.	Kinks and crimps in the Tygon™ tubing.	Periodically check the Tygon™ tubing inside the instrument.
High erratic results	Internal mercury contamination	<ol style="list-style-type: none"> 1. Install zero air filter in intake and tighten intake nut. Press SAMPLE button. After 3 samples, if readings are over .003 mg/m³, replace intake filters and Tygon tubing. 2. Perform a REGEN with zero air filter in intake. See page 6 for information. Retest if necessary. Replace intake filters and Tygon™ tubing.

Symptom	Possible Cause	Solution
High/erratic results Readings vary more than 0.05 when in survey mode.	Film connection	Press and hold SAMPLE button for 12 seconds in clean area or with zero air filter in intake. Move unit from side to side, or up and down during sample cycle.
Low response or erratic readings after a long period of non-use	May need a second regeneration cycle.	Call AZI Customer Service. Wait 20 minutes between regeneration cycles. Test with FTK. See page 37 for information. If still unresponsive, call AZI Customer Service.
False readings, may go to .8.8.8 or .L.L.L	Extremely cold or extremely warm air sampled into unit	If sampling under these conditions, install zero air filter in intake. Sample until display reads .003 mg/m ³ or less. This equilibrates sensor temperature with the temperature of the sample air stream. Remove filter and take samples.
High/erratic results	Intake and internal filters may get clogged and need replacement when sampling in a dusty area	Open instrument to check for pinched, crimped or disconnected internal tubing. In extreme conditions a particle filter may be installed on intake.

Symptom	Possible Cause	Solution
Miscellaneous Problems		
Display reads .P.P.P when regeneration is attempted.	Power cord not attached	Check power cord for connection
	Blown fuse	Replace fuse. See page 17 for information.
	Line voltage less than 100 VAC (or less than 200 VAC for 220 unit)	Check line voltage settings. See page 16 for information.
	Cycles dipswitch (50 or 60Hz) set incorrectly	Check input cycle settings. See page 16 for information.. If fuse and line voltage are OK, it may be circuit board adjustment or component, call AZI Customer Service for information.
Display reads .E.E.E	Very low battery	Recharge battery. See page 10 for information.
If battery is charged		Replace battery. See page 15 for information..
	Blown fuse	Replace fuse. See page 17 for information.
	Internal component failure	Call AZI Customer Service for information.

8 JEROME 431-X TECHNICAL SPECIFICATIONS

Range	0.003 to 0.999 mg/m ³
Sensitivity	0.003 mg/m ³ Hg
Precision	5% relative standard deviation @ 0.100 mg/m ³ Hg
Accuracy	+/- 5% @ 0.100 mg/m ³ Hg
Response time-sample mode	12 seconds
Response time-survey mode	3 seconds
Flow rate	750cc/min (0.75 liters/min)
Power requirements	100-130 VAC (or 200-260 VAC) 115 watts maximum
Batteries	Rechargeable Nickel Cadmium
Fuse	1A 250V 5 X 20 Fast Blo
Construction	Aluminum alloy
Dimensions	15 cm x 33 cm x 10 cm (6" w x 13" l x 4" h)
Weight	3.18 kilos (7 pounds)
Digital meter	Liquid crystal display (LCD)
Operating environment	0° - 40°C, non-condensing, non-explosive

8.1 OPTIONAL "COMMUNICATIONS" VERSION

Alarm output	30V DC, 100mA
Dosimeter power output	For dosimeter analysis
Data output	<ol style="list-style-type: none">1. Digital, Serial, RS232, Baud Rate 1200 for use with Data Logger, Base Station, and/or JCI program software2. Digital, Serial, RS232, data format, but with driver for 20mA capability and 0 & 20mA logic levels; Baud Rate 1200 (special industrial applications)

"OPTION BOARD"

Data output	0 - 2V or 4 - 20 mA
Auto sample interval	5, 15, 30, 60 minutes
Auto regeneration interval	6, 24 or 72 hours

8.2 INSTRUMENT I/O INTERFACE

The 431-X I/O port (25 pin D-sub) has six functions:

! Serial communication channel, RS-232

Interface type RS-232C full duplex, DCE

Communication parameters - 1200 Baud, 1 start bit, 8 data bits, 2 stop bits, no parity

Pin assignments:

Pin 1	Protective ground
Pin 2	Data in
Pin 3	Data out
Pin 7	Data ground

! Serial communication channel, 20mA current loop

Interface type: 20mA current loop, full duplex

Communication parameters - 1200 Baud, 1 start bit, 8 data bits, 2 stop bits, no parity

Pin assignments:

Pin 1	Protective ground
Pin 4	Data out (+)
Pin 5	Data in (+)
Pin 14	Data out (-)
Pin 16	Data in (-)

! Alarm output

Maximum voltage 30 VDC

Maximum current 100mAmp

Pin assignments:

Pin 9	Switched battery+
Pin 10	Alarm output (open collector, active low)
Pin 7	Battery ground
Pin 23	Battery ground

! Dosimeter power

Voltage 24 - 28 volts AC

Pin assignments:

Pin 22	Dosimeter enable
Pin 23	Battery ground
Pin 12 & 24	Dosimeter power
Tied together	
Pin 13 & 25	Dosimeter power
Tied together	

Connecting pin 22 to 23 enables the dosimeter desorption cycle.

! Switched battery connection for data logger

Pin assignments:

Pin 9	Battery +
Pin 7	Battery ground
Pin 23	Battery ground

! Unswitched battery connection for external battery pack pin assignments

Pin assignments:

Pin 15	Battery +
Pin 19	Battery +
Pin 7	Battery ground
Pin 23	Battery ground

NOTE: Pins 6, 8, 11, 17, 18, 20 and 21 are non-standard and should not be connected.

8.3 POTENTIAL INTERFERENCES

Potential interferences to the Jerome mercury vapor analyzers are rare and most of these can be eliminated with proper maintenance procedures. However, erroneously high readings can sometimes occur. Here are a few things to be aware of when using the instruments.

The gold film sensors used in the Jerome mercury vapor analyzers do not respond to the following compounds:

- Hydrocarbons
- CO, CO₂, and SO₂
- Water vapor (Note that water vapor condensation on the gold film can cause irreparable harm to the sensor and must be avoided.)

The acidic gas filter, contained in the internal filter system, removes the following compounds that cause the gold film sensor to respond:

- Chlorine
- NO₂
- Hydrogen Sulfide (H₂S)
- Most mercaptans (organic sulfur compounds or "thiols")

In areas containing these highly volatile compounds, the filter can become quickly saturated. In such situations, it is recommended that these gases be allowed to dissipate before sampling for the less volatile, more persistent mercury vapor. Collection of air samples with Jerome gold coil dosimeters for analysis by the Jerome mercury vapor analyzers will also eliminate interferences.

Ammonia in very high concentrations can cause an offgassing of accumulated acidic fumes from the internal acidic gas filter, resulting in positive readings on the instrument. In these cases, the ammonia odors are very strong. Again, either allow the vapors to dissipate or use the dosimeters. Filter replacement at regular intervals, or when unexpectedly high readings are encountered in areas of these potential interferents, may resolve these problems.

Volatile mercury compounds in general will cause the gold film to respond. Alkyl organic mercuries such as methyl mercury (and other "straight chained" compounds) are typically extremely volatile and change the electrical resistance of the gold film sensor. Any such responses should be considered "qualitative," not quantitative. The instruments are designed and calibrated to elemental mercury vapor only.

Inorganic mercury salts such as mercuric chloride are not very volatile. They may, however, generate some minute level of elemental mercury vapor to which the instruments will respond. This response, again, should be considered a qualitative response only.

9 ACCESSORIES & MAINTENANCE PARTS

PART #	ITEM DESCRIPTION
Y431-0901	431 Accessory Kit Includes: zero air filter (1), .25mm fritware (20), trimmer tool (1), probe (1) & tubing adapter (1)
Y431-0902	Functional Test Kit Includes: calibration vessel (1), stopper assembly (1), vial with Hg (1), syringe assembly (1), disposable syringe needles (5), septum holder assembly opt. (1) & septa - 1/4" (20)
Y431-0903	431 Maintenance Kit Includes: zero air filter (1), .25 mm fritware (60), 021 battery pack (1), C/M filter (1), scrubber filters (2) & 1 foot Tygon™ tubing - 1/8" I.D.
Y411-0904	031/411 Carrying Case Assembly Includes: case & die cut foam rubber Holds: Jerome 431-X, personal mercury dosimeters & accessories
1400-0052	001 Field Carrying Case Assembly
Y431-0905	Standard Dosimeter Analysis Kit Includes: dosimeter lead set (1), low flow pump - 2cc/min (1), personal mercury dosimeters (2), zero air filter (1), 1/8" - 1/16" adapter (1), 2' Tygon™ tubing - 1/8" I.D., 1' Tygon™ tubing - 1/16" I.D.
X412-0901	Personal Mercury Dosimeter
2100-6017	Dosimeter Lead Set
2600-2011	Dosimeter Pump - 2cc/min
ZZ600-3911	10:1 Dilution Module Assembly

9.1 431-X FLOW SYSTEM

Z2600-3930	Scrubber Filter
Z2600-3928	C/M Filter
Z2600-3905	Zero Air Filter
1400-3010	Tubing Adapter
2600-3039	.25mm Fritware
2500-3001	Tygon™ Tubing - 1/8" I.D. (1 foot)
1400-3009	Intake Nozzle
PS-151	Tube Nut

9.2 REPLACEMENT PARTS

Z4000-0907	021 Battery Pack Assembly
4000-1011	IDC Battery Charger - 115 VAC
4000-1012	IDC Battery Charger - 230 VAC
1300-0025	1/8" - 1/16" Tubing Adapter
1400-2002	Probe
2300-0001	Trimmer Tool
2500-3002	Tygon™ Tubing - 1/16" I.D. (1 foot)
6000-4003	Line Cord
5100-1012	Fuse 1 AMP 5 X 20 250V Fast-Blo

9.3 TEST EQUIPMENT

2600-0030	Calibration Vessel
A2600-0902	Stopper Assembly
	Includes: rubber stopper, thermometer & needle guide
A2600-0903	Syringe Assembly
	Includes: syringe, syringe holder & needle
2600-0022	Syringe Needles (2)
Z2600-3914	Septum Holder Assembly
3200-0011	Septum - 1/4" (20)
A2600-0904	Vial with Hg

For current prices and delivery information, call AZI Customer Service at 800-235-3360 or 602-470-1414.

FACTORY CALIBRATION SERVICE

Service includes filter replacement, component check and calibration and instrument calibration to NIST traceable standards.

For authorization & scheduling, call AZI Customer Service at 800-235-3360 or 602-470-1414.

10 MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

10.1 MALLCOSORB

Arizona Instrument Corporation
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification

SYNONYMS: Soda lime solid; sodium hydroxide mixed with lime
FORMULA CAS NO.: 8006-28-28
MOLECULAR WEIGHT: N/A
HAZARDOUS INGREDIENTS: N/A
CHEMICAL FORMULA: N/A

Section 1 - Physical Data

APPEARANCE: White deliquescent pellets
ODOR: Odorless
BOILING POINT: No information found
MELTING POINT: No information found
VAPOR PRESSURE @ 20°C: Essentially zero
SPECIFIC GRAVITY: No information found

Section 2 - Fire and Explosion Data

FIRE: Not combustible, contact with moisture may generate heat to ignite combustibles.
EXPLOSION: Possible when in contact with incompatible materials.
FIRE HAZARD: Full protective clothing & NIOSH approved self-contained breathing apparatus.

Section 3 - Reactivity Data

STABILITY: Causes no hazardous decomposition or hazardous polymerization
INCOMPATIBILITIES: Water, steam, acids, fluorine & many organics; contact with nitro compounds cause formation of flammable hydrogen gas.

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Protective clothing & respiratory protection, scoop up spilled material, avoid dusting, neutralize traces with dilute acid.
DISPOSAL: Transfer to closed metal container & dispose of according to local, state & federal regulations. DO NOT CONTACT WITH WATER.

Section 5 - Health Hazard Information

OSHA PERMISSIBLE EXPOSURE LIMIT(PEL):

Calcium Oxide 5 mg/m³ (TWA)

Sodium Hydroxide 2 mg/m³ (TWA)

ACGIH THRESHOLD LIMIT VALUE (TLV):

Sodium Hydroxide 2 mg/m³ (TWA)

Calcium Oxide 2 mg/m³ (TWA)

EXPOSURE/HEALTH EFFECTS:

INHALATION - Upper respiratory tract damage, pneumonitis;

INGESTION - Severe mouth, throat & stomach burns, severe tissue scarring & death may result;

SKIN & EYES - Irritation or severe burns, possible blindness resulting

FIRST AID:

INHALATION - Remove to fresh air; if not breathing, give artificial respiration; if breathing is difficult, give oxygen; get medical attention immediately.

INGESTION - DO NOT INDUCE VOMITING! give large quantities of water or milk; get medical attention immediately.

SKIN & EYES - Immediately flush with water for 15 minute minimum; remove contaminated clothing.

Section 6 - Special Protection Information

Ventilation must be sufficient to meet TLV. Wear rubber gloves & eye protection.

Section 7 - Storage and Special Information

Keep in tightly closed container, in cool, dry ventilated area, away from incompatible substances.

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

MALLCOSORB

Addendum to Material Safety Data Sheet

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Hazard Categories for SARA Section 311/312 Reporting

Acute Chronic Fire Pressure Reactive

X

Product or Components of Product	SARA Sect. 302 EHS		SARA 313 Chemicals Sect.		CERCLA Sec103 RQ (lbs)	RCRA Sec. 261.33
	RQ (lbs)	TPQ (lbs)	Name List	Chemical Category		
MALLCOSORB™ Sodium hydroxide (1310-73-2) 1-10%	No	No	Yes	No	1000	No
Calcium chloride (10043-52-4)	No	No	No	No	No	No
Ethyl violet (2390-59-2)	No	No	No	No	No	No
Calcium hydroxide (1305-62-0)	No	No	No	No	No	No
Actual concentrations proprietary						

SARA Section 302 EHS RQ: Reportable quantity of extremely hazardous substance, listed at 40 CFR 355.

SARA Section 302 EHS TPQ: Threshold-Planning Quantity of extremely hazardous substance. An asterisk (*) following a Threshold Planning Quantity signifies that if the material is a solid and has a particle size equal to or larger than 100 micrometers, the Threshold Planning Quantity = 10,000 lbs.

Section 313 Chemicals: Toxic substances subject to annual release reporting requirements listed at 40 CFR 372.65.

CERCLA Sec. 103: Comprehensive Environmental Response Compensation and Liability Act (Superfund) Releases to air, land or water of these hazardous substances which exceed the Reportable Quantity (RQ) must be reported to the National Response Center (800) 414-8802; listed at 40 CFR 302.4.

RCRA: Resource Conservation and Reclamation Act. Commercial chemical product wastes designated as acute hazards and toxic under 40 CFR 261.33

MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

10.2 MERCURY

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification:

CHEMICAL NAME: Mercury metal
TRADE NAME & SYNONYMS: Quick Silver
CHEMICAL FAMILY: Metals
FORMULA: Hg
FORMULA WEIGHT: 200.59

Section 1 - Physical Data

ODOR: Odorless
SPECIFIC GRAVITY ($H_2O = 1$): 13.54
VAPOR PRESSURE AT 20°C (mmHg): 0.0012
BOILING POINT, 760 mm Hg (°C): 356.9
MELTING POINT (°C): -38.9

Section 2 - Fire and Explosion Data

FIRE HAZARD: Nonflammable
UNUSUAL HAZARDS: Extremely toxic vapors upon exposure to high temperatures.

Section 3 - Reactivity Data

STABILITY: Stable at room temperature
INCOMPATIBILITIES AND REACTIVITIES:
Acetylene, ammonia, chlorine dioxide, azides, calcium (amalgam formation), sodium carbide, lithium, rubidium, copper, nitric acid

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Recover with suction cup equipped with a capillary tube.
DISPOSAL METHOD: Perform in compliance with all current local, state and federal regulations.

Section 5 - Health Hazard Information

EXPOSURE LIMIT

0.05mg/m³ (NIOSH/TWA)
0.100mg/m³ Ceiling (OSHA)

EXPOSURE/HEALTH EFFECTS: Coughing, bronchitis, pneumonia, tremor, insomnia, irritability, headache, fatigue, weakness, stomatitis, weight loss, GI disorder

SKIN & EYES: Can irritate skin and eyes

FIRST AID:

SKIN: Wash with water, get medical assistance.
EYES: Wash with water, get medical assistance.
INHALATION: Remove to fresh air, get medical assistance.
INGESTION: Get medical assistance.

Section 6 - Special Protection Information

Ventilation must be sufficient to meet TLV. Wear rubber gloves and eye protection.

Section 7 - Special Handling and Storing Precautions

Do NOT heat mercury unless appropriate safety precautions for highly toxic vapors have been taken. Store in sealed container.

Section 8 - Hazardous Ingredients

Mercury and Mercury vapor

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however, makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

MATERIAL SAFETY DATA SHEET

Date of Issue 04/95

10.3 RESISORB

ARIZONA INSTRUMENT CORPORATION
4114 East Wood Street
Phoenix, AZ 85040
INFORMATION HOTLINE (800) 235-3360

Product Identification:

PRODUCT NAME: Resisorb - Mercury Vapor
Absorbent
FORMULA CAS NO.: 00000-00-0
MOLECULAR WEIGHT: .00
CHEMICAL FORMULA: Proprietary mixture

Section 1 - Physical Data

APPEARANCE & ODOR: Black solid with halogen-like odor
BOILING POINT: N/A
MELTING POINT: N/A
VAPOR PRESSURE: N/A
SPECIFIC GRAVITY: N/A

Section 2 - Fire and Explosion Hazard Data

FIRE: Combustible, keep away from heat, sparks, flame.
EXPLOSION: Contact with strong oxidizers may cause explosion.
FIRE HAZARD: Use water spray to soak, class A extinguisher, gull protective clothing & NIOSH approved self-contained breathing apparatus, move exposed containers from fire area if it can be done without risk, if not, use water to keep fire-exposed containers cool.

Section 3 - Reactivity Data

STABILITY: Stable, no hazardous polymerization
CONDITIONS TO AVOID: Heat, flame, sources of ignition
INCOMPATIBILITIES: Strong oxidizing agents, nitric acid, ammonia, alkali metals, strong reducing agents

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Protective clothing & respiratory protection, scoop up spilled material, avoid dusting, flush spill area with water.
DISPOSAL: Transfer to clean, dry container & dispose of in accordance with local, state & federal environmental regulations.

Section 5 - Health Hazard Information

EXPOSURE/HEALTH EFFECTS:

INHALATION: May cause tightness & chest pain, coughing & difficulty in breathing.
INGESTION: May cause nausea, vomiting, headaches.
SKIN AND EYES: Dust may irritate skin and/or eyes.

FIRST AID:

INGESTION: get medical attention, if conscious, immediately induce vomiting.
SKIN AND EYES: Immediately flush with water for 15 minute minimum; remove contaminated clothing.

Section 6 - Special Protection Information

Use adequate general or local ventilation to keep fume or dust levels as low as possible. If airborne concentration is high, use respirator or dust mask. Wear rubber gloves & eye protection.

Section 7 - Storage and Special Information

Keep in tightly closed container, in cool, dry ventilated area, away from heat, sparks or flame; isolate from incompatible substances.

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however, makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

MATERIAL SAFETY DATA SHEET

10.4 NICKEL CADMIUM BATTERY

MATSUSHITA BATTERY INDUSTRIAL CO
1 Matsushita-Cho
Moriguchi Osaka 570 JAPAN
EMERGENCY TELEPHONE 201-392-6703
INFORMATION TELEPHONE 714-373-7538

Product Identification:

PRODUCT NAME: Nickel Cadmium Battery
HAZARDOUS INGREDIENTS: $\text{Ni}(\text{OH})_2$, NiOOH ,
 Cd , $\text{Cd}(\text{OH})_2$, KOH or NaOH , LiOH
CHEMICAL FORMULA: NiCd

Section 1 - Physical Data

APPEARANCE & ODOR: None
BOILING POINT: Approximately 170°C
MELTING POINT: N/A
VAPOR PRESSURE: N/A
SPECIFIC GRAVITY: 2.6

Section 2 - Fire and Explosion Data

FIRE HAZARD: Under normal charging and
discharging, no fire hazard exists.
EXPLOSION: Under normal charging and
discharging, no explosion hazard exists.

Section 3 - Reactivity Data

STABILITY: Extremely stable
INCOMPATIBILITIES: N/A

Section 4 - Leak/Spill Disposal Information

PRODUCT CLEAN-UP: Non-toxic in normal use
DISPOSAL METHOD: DO NOT incinerate.
Dispose of in discharged state to avoid shorting.

Section 5 - Health Hazard Information

EXPOSURE/HEALTH EFFECTS:

INHALATION: N/A

INGESTION: N/A

SKIN AND EYES: May irritate if contact is made
with the electrolyte (alkaline).

FIRST AID:

INHALATION: N/A

INGESTION: N/A

SKIN AND EYES: Immediately flush affected area
with cool water. If contact is made with the eyes or
mucous membranes, immediately flush with water
and get medical assistance.

Section 6 - Special Protection Information

No special protection required in normal usage.

Section 7 - Storing and Special Information

No special precautions required for storing.

The information and recommendations set forth herein are presented in good faith and believed to be correct as of the date hereof. Arizona Instrument Corporation, however, makes no representations as to the completeness or accuracy thereof and information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Arizona Instrument Corporation be responsible for damages of any nature whatsoever resulting from the use of or reliance upon this information.

11 APPENDIX A - 431-X FUNCTIONAL TEST

If your application requires frequent verification of instrument functionality, this test will benefit you. If the test results fall within the expected range, you may assume the instrument is functioning properly. This test does not calibrate the instrument.

NOTE: Perform the functional test **ONLY** after a sensor regeneration.

The 431-X Functional Test Kit contains all accessories necessary to perform the functional test:

- calibration vessel (1)
- stopper/thermometer assembly (1)
- vial of Hg* (1)
- syringe assembly (1)
- syringe needles (5)
- septum holder assembly (1)
- septa (20)

CAUTION: The vial and thermometer contain liquid mercury and are possible sources of mercury contamination. Follow the instructions carefully.

***For information on special protection and health hazards, READ the Mercury Material Safety Data Sheets (MSDS), page 31 before handling or transferring the mercury into the Functional Test Kit Vessel.**

11.1 PREPARATION

! Carefully unpack and inspect the parts of the kit.

ENSURE that the mercury shipping container and mercury filled thermometer are not broken.

VERIFY that all the parts to the kit are present.

! In a ventilated area, preferably under a fume hood, remove the mercury vial from its shipping container.

! Place the functional test kit vessel and the mercury vial close to each other and open the mercury vial.

CAUTION: The edge between the plastic case and the glass inner vessel of the functional test kit vessel are not sealed well enough to prevent mercury from entering the area between the inner and outer vessels. **ENSURE** the mercury, handled in the next step, does not come in contact with the seal where the glass and plastic portions join.

NOTE: The vessel may be disassembled to transfer the mercury and better prevent contamination of the outer portion of the vessel. Instructions to disassemble the vessel can be found on page 36.

11.2 MERCURY TRANSFER

PROCEDURE:

- ! **CAREFULLY** pour the mercury into the center of the functional test kits vessel's opening.
- ! **ENSURE** that no mercury residue is on the outside of the vessel. If mercury residue is present, see the mercury Material Safety Data Sheet (MSDS) on page 31 for clean-up instructions.
- ! **INSTALL** the stopper assembly into the functional test kit vessel carefully, to prevent breakage of the thermometer.

PRESS the stopper assembly into the vessel to achieve a good seal.

- ! **USE** the 431-X instrument to verify that the outside of the vessel is not contaminated and the mercury vapor emission level, if any, is below the OSHA TLV for mercury.
- ! **ALLOW** the kit to adjust to room temperature for at least two (2) hours before using.

The temperature range for the test is 18-22°C. Avoid temperature fluctuations.

CAUTION: Do not use the calibration vessel as a portable container. If the calibration vessel is upset or greatly agitated, mercury droplets will cling to the thermometer stem, the rubber stopper, the mouth of the calibration vessel and the needle guide.

11.3 VESSEL DISASSEMBLY

CAUTION: The inner portion of the vessel is made of glass. Handle the vessel carefully to prevent breakage.

! LOOSEN, BUT DO NOT REMOVE the base of the vessel. The base unscrews from the body.

! SET the vessel on a firm surface.

! HOLD the base stationary and unscrew the body from the base.

! HOLD the base and the inner glass vessel with one hand while removing the body and gasket with the other hand.

! After the mercury is transferred into the glass inner vessel, reassemble in the reverse order.

11.4 REPLACING MERCURY

An oxide coating will form on the drop of mercury and will cause lower readings in your testing. Gently swirl the vessel to disturb the outer oxidized surface of the droplet. If this does not restore higher readings, it may be necessary to replace the mercury.

PROCEDURE:

! Carefully remove the stopper assembly from the calibration vessel.

BE SURE NEEDLE GUIDE IS FREE OF LIQUID MERCURY.

! Carefully pour the mercury into a disposal vessel. Refer to Vessel Disassembly Instructions on 36.

Mercury can become trapped between the plastic calibration vessel and the glass inner-liner.

! Replace the oxidized mercury with approximately ½ cc fresh mercury. (AZI P/N A2600-0904)

Do NOT use the syringe for measuring liquid mercury. Dispose of oxidized mercury properly.

! Reassemble the calibration vessel.

! Reinstall the stopper assembly.

11.5 FUNCTIONAL TEST PROCEDURE

NOTE: Perform the functional test ONLY after a sensor regeneration.

PROCEDURE:

! Leave the calibration vessel at stable room temperature for at least 2 hours.

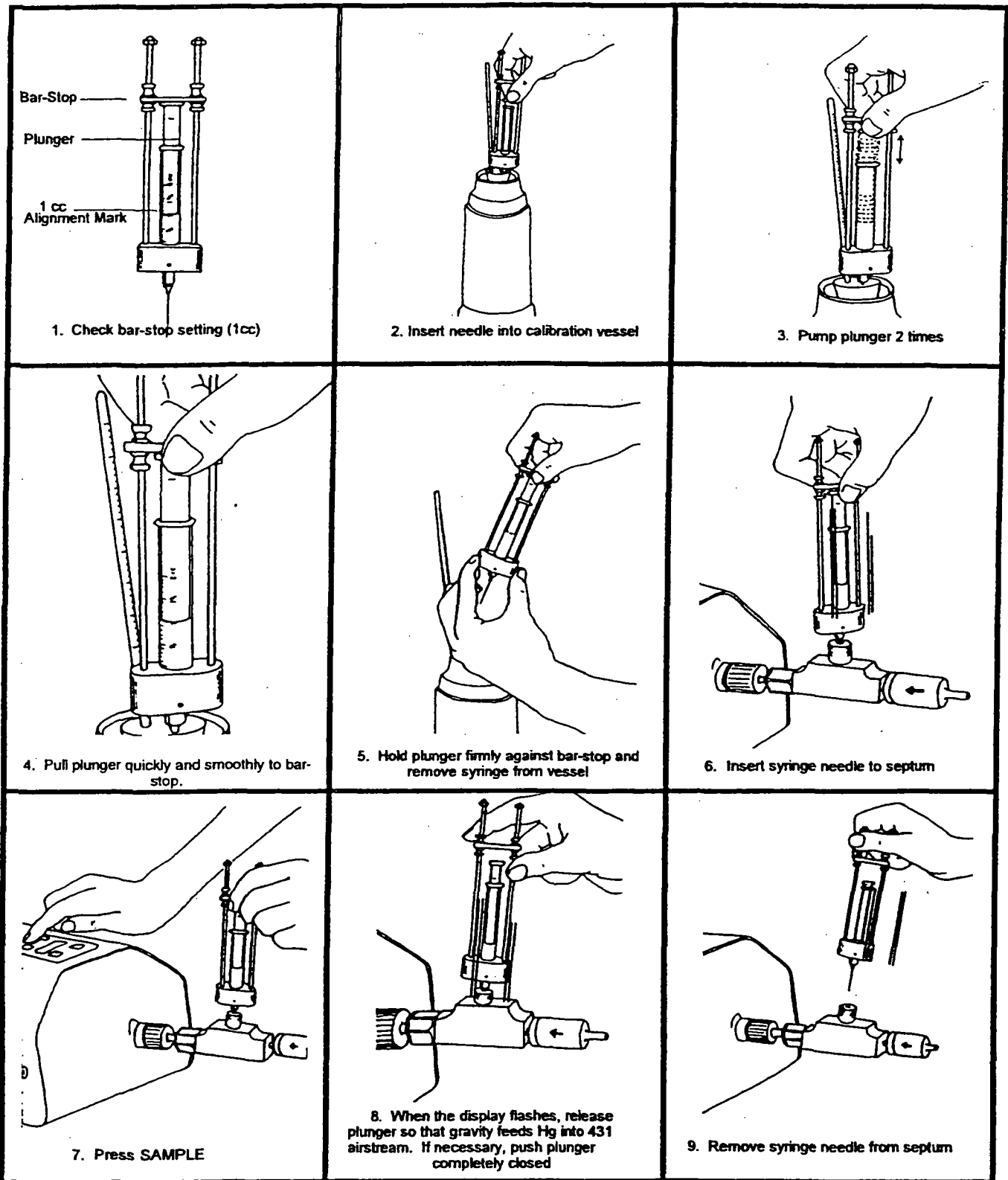
The temperature range for the test is 18° - 22°C.

Temperature fluctuations during the test procedure will produce erratic results.

! Replace the .25mm fritware.

Refer to page 13 of the 431-X manual.

11.6 SYRINGE TECHNIQUE



! Replace the septum on the septum holder assembly.

! Plug the tubing adapter end of the septum assembly into the instrument's intake and tighten the intake tube nut.

NOTE: To check for a tight seal, gently pull on the septum holder assembly. If it comes out of the intake, it may be necessary to remove the intake tube from the instrument and firmly press the tubing adapter through the intake. Tighten the intake tube firmly to the intake stem.

! Attach a zero air filter to the septum assembly.

! Press power ON.

! Take 3 samples.

If the average meter reading is less than .005, continue to the next step.

If the average meter reading is greater than .005, stop here. The instrument may be contaminated. See the Troubleshooting section, page 19.

! Note the temperature of the calibration vessel.

! Press the SAMPLE button, wait 2 seconds and **when the display flashes**, inject 1 cc of mercury vapor according to the syringe technique described on page 38. Be sure all mercury vapor has been injected before the solenoid closes (second click and display flash).

NOTE: To minimize error, it is important to carefully follow this procedure.

! Record the meter reading.

! Repeat the last two steps three times.

The last three 1cc injections should be within +/- 5% of each other. If not, refer to page 38 for proper syringe technique and repeat the procedure.

! Refer to the Temperature Conversion Chart, page 40, for the acceptable range.

The average of the last three digital meter readings should fall within the range shown on the chart.

IF THE AVERAGE IS WITHIN RANGE, THE JEROME 431-X IS FUNCTIONING PROPERLY.

! Perform a sensor regeneration. Press ZERO and turn the ZERO ADJUST (refer to page 6 in the 431-X manual for the complete sensor regeneration procedure).

! Wait 1 hour before proceeding to the next step.

! Repeat this test procedure.

If the average of the digital meter readings is still not within range, refer to page 41 Functional Test Troubleshooting.

431-X Temperature Conversion Chart

Temperature°C	Digital Meter Response
16	.091 to .123
17	.100 to .135
18	.108 to .146
19	.118 to .159
20	.129 to .174
21	.138 to .187
22	.151 to .204
23	.164 to .222
24	.177 to .240

11.7 FUNCTIONAL TEST TROUBLESHOOTING

If you don't achieve good results with the functional test procedure, check the following:

Results	Solution
Too low	Be sure to inject the Hg vapor ONLY after the display flashes (2 seconds after SAMPLE is pressed).
Typically too high	Ensure the calibration vessel temperature is stable.
Too low	Ensure there is no oxidation on the mercury drop in the calibration vessel. Gently swirl the mercury drop in the calibration vessel. Replace if necessary.
Too low	Ensure the instrument's intake is not blocked with foreign matter. Check flow with a flow meter.
Too low	Use a new syringe needle. Straighten or replace crimped or blocked internal tubing.

If you find the above does not solve your problems, please call AZI Customer Service at (800) 235-3360 or 602-470-1414.

12 APPENDIX B - GOLD COIL PERSONAL MERCURY DOSIMETER

12.1 INTRODUCTION

The gold coil personal mercury dosimeter is a unique collection device for mercury vapor. The Jerome 431-X Gold Film Mercury Vapor Analyzer and the Personal Mercury Dosimeter determine personal exposure levels and ambient air concentrations, as well as low levels of mercury in natural and stack gases

For personal sample collection, the dosimeter is worn as close to the wearer's breathing zone as possible and is connected by tubing to a pump usually worn on a belt. The dosimeter can also be used for multiple point area monitoring by placing a dosimeter, with pump attached, in various strategic locations.

We recommend a pump flow rate of 2 cc/minute for the most accurate results when sampling in an atmosphere that for eight hours may contain an average of .5 mg/m³ Hg. If you are considering using any other flow rate, see page 46, Nonstandard Flow Rates.

After sample collection is completed, the dosimeter is inserted in the Jerome 431-X's intake. A dosimeter lead set is connected between the dosimeter and the 25 pin connector on the back of specially equipped instruments. The instrument supplies power to volatilize the accumulated mercury from the dosimeter to the gold film sensor. The Jerome 431-X determines the mass of mercury collected by the dosimeter in a 17 second analysis. The dosimeter is ready for immediate re-use after a mercury measurement has been performed.

12.2 DOSIMETER TECHNICAL SPECIFICATIONS*

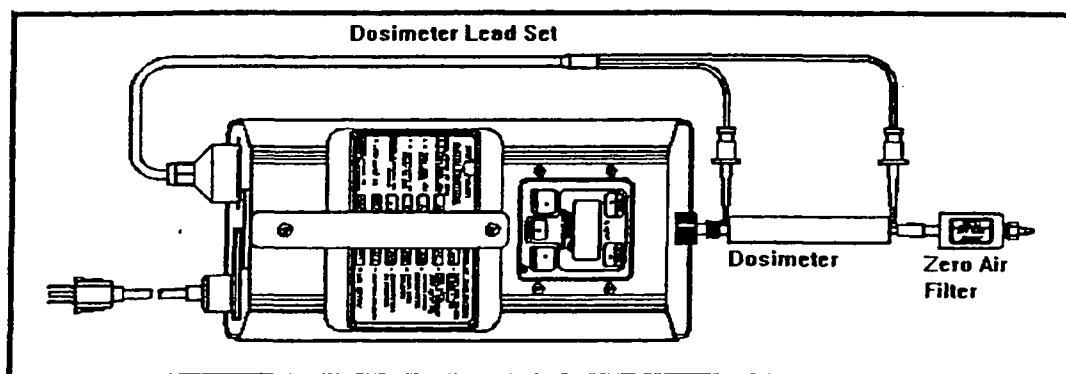
Sensitivity	< 0.5 x 10 ⁻⁹ g Hg
Precision	15% RSD @ 0.100 mg/m ³ Hg
Accuracy	15% @ 0.100 mg/m ³ Hg
Recommended flow rate	2 cc/min (0.002 liters/min) for atmospheres of 0.5 mg/m ³ 60 cc/min for 100% collecting efficiency in atmospheres with lower concentrations
Construction	Nylon/Glass

Weight	1.5 ounces
Dimensions	0.5" dia. x 4.5" l
Capacity	1000 X 10 ⁻⁹ g Hg
Analysis Time	< 2 min

*Based on 2 cc/min flow rate

12.3 BEFORE SAMPLING WITH THE DOSIMETER

The personal mercury dosimeter adsorbs mercury vapor over a period of time. Therefore,



before each day's use it is necessary to ensure the dosimeter is mercury free. Perform the following steps to remove any accumulated mercury.

PROCEDURE:

! Connect the system as shown in the figure above.

Insert the dosimeter's large end in the 431-X's intake and gently tighten the intake tube nut to ensure an airtight seal.

! Attach the power cord to the 431-X and plug it into AC power.

AC power is required to heat the dosimeter.

! Press the Jerome 431-X's power ON button.

! Press the Jerome 431-X's SAMPLE button.

The digital meter reading will appear in 15 seconds.

! Wait 60 seconds and press the SAMPLE button again.

The Jerome 431-X's digital meter should display less than 0.005, verifying all mercury has been removed from the dosimeter coil.

! The dosimeter is ready for sample collection.

NOTE: For best results, dosimeter analysis should be performed as soon after collection as possible. If analysis cannot take place immediately after sampling is completed, cap both ends of the dosimeter with Tygon™ tubing sealing it completely, or replace with the end caps. For accurate results, perform dosimeter analysis no later than five days after sampling.

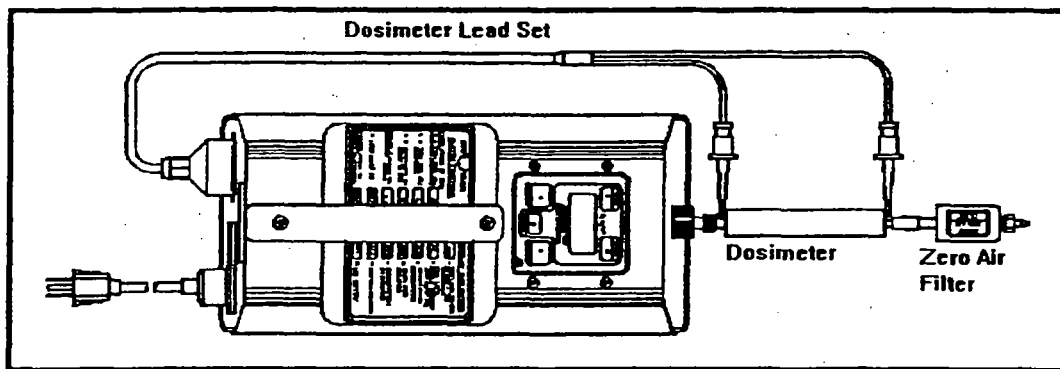
12.4 DOSIMETER ANALYSIS

PROCEDURE:

NOTE: Wait a minimum of 30 minutes after a sensor regeneration before starting this procedure.

! Connect the system as shown in the figure below.

! Attach the power cord to the 431-X and plug it into AC power.



AC power is required to desorb mercury from the dosimeter.

! Press the Jerome 431-X's power ON button and then press SAMPLE button.

The digital meter reading appears in 15 seconds.

! Record the digital meter reading (include the decimal point). Wait 30 seconds, then press SAMPLE again and record this digital meter reading.

Repeating the heating process ensures complete release of mercury from the dosimeter coil.

! Add the two digital meter readings together.

The sum of the two digital meter readings is the figure you will use in your calculations and is referred to as the meter response.

NOTE: A third dosimeter desorption should give .005 mg/m³ or less.

! You can perform the following calculation to obtain the mercury concentration in mg/m³ based on a time weighted average; or alternately, DIP switch #2 can be set to OFF and the digital meter will display nanograms Hg directly (refer to diagram, page 17).

Working Formula and Units of Measure
(MR x 87.5)/SV=Sample Concentration

MR(meter response)	total of the two digital meter readings in mg/m ³
87.5 ng/mg/m ³	(conversion factor, a constant which changes the meter response to nanograms of Hg)
SV (sample volume)	pump flow rate (in cc/min) multiplied by sample time (in minutes)
Sample concentration	in ng/cc mg/m ³

EXAMPLE:

(to calculate a time weighted average during an 8 hour period)

Meter response	0.600 mg/m ³ (sum of the two meter response readings)
Conversion factor	87.5 ng/mg/m ³ (constant)
Pump flow rate	2 cc/min
Sampling time	8 hours (480 min)
Sample volume	2 cc/min x 480 min = 960cc

$$(0.600 \text{ mg/m}^3 \times 87.5 \text{ ng/mg/m})/960\text{cc} = 0.055 \text{ ng/cc}$$

- A. Convert the meter response (the total of the two digital meter readings) to nanograms of mercury.

$$0.600 \times 87.5 = 52.5 \text{ nanograms of Hg}$$

- B. Determine the total volume of air sampled.

$$2 \text{ cc/min} \times 60 \text{ min/hr} \times 8 \text{ hr} = 960 \text{ cc}$$

C. Determine the Hg concentration (time weighted average) of the dosimeter.
 $52.5 \text{ nanograms}/960 \text{ cc} = 0.055 \text{ ng/cc of Hg} = 0.055 \text{ mg/m}^3 \text{ of Hg}$

! Check the sensor status after each dosimeter analysis.

IMPORTANT: Perform a sensor regeneration as soon as the meter display shows "----" (four bars) which shows 75-100% sensor saturation to prevent the loss of a sample.

! Seal the dosimeter with caps or Tygon™ tubing after analysis to prevent mercury contamination during storage.

NOTE: If your average dosimeter analysis produces nanogram levels of 75 or more, you risk overranging your instrument and losing your collection data. Call Customer Service at 800-235-3360 or 602-470-1414 for alternative collection methods.

12.5 NON-STANDARD FLOW RATES AND DILUTION MODULES

You may use a pump with a flow rate up to 50 or 60 cc/min, but be aware that there are certain limitations. If your pump flow rate exceeds 2 cc/min and your average dosimeter analysis produces nanogram levels of 75 or more, it may be easy to collect more mercury beyond the linear range of the 431-X sensor. You thus risk overranging your instrument and losing your collection data. Higher flow rates may also impair the capture efficiency of the dosimeter.

We recommend that you drop your flow rate or use a dilution module* (AZI P/N Z2600-3911). Lowering the flow rate to decrease the sample volume provides the greatest accuracy. Using a dilution module introduces an additional 15% inaccuracy to your analysis. As an alternative to the dilution module, sample for shorter time periods.

Dilution Module Specifications

Accuracy	+/- 15% of 10:1 ratio
Input concentration range:	
Low	0.7 mg/m ³ Hg
High	5.0 mg/m ³ Hg
Housing	Nylon
Dimensions	1" w x 2.7" l x 3" h
Weight	3.3 oz

The dilution module is factory set to a 10:1 ratio. The mass of mercury entering the dilution module is reduced by 90%, leaving a 10% (X10 dilution) concentration to be introduced into the Jerome 431-X. since this ratio can change slightly with use, it is important to occasionally determine the current dilution module ratio to ensure accurate

results. For normal applications a X8 to X12 ratio is recommended. The 431-X Functional Test Kit contains all accessories necessary to determine the current dilution module ratio.

Call Customer Service at 800-235-3360 or 602-470-1414 if you have questions about flow rates or applications.

*The dilution module contains Resisorb™, mercury vapor adsorbent. For safety information, see the Resisorb™ Material Safety Data Sheet on page 32.

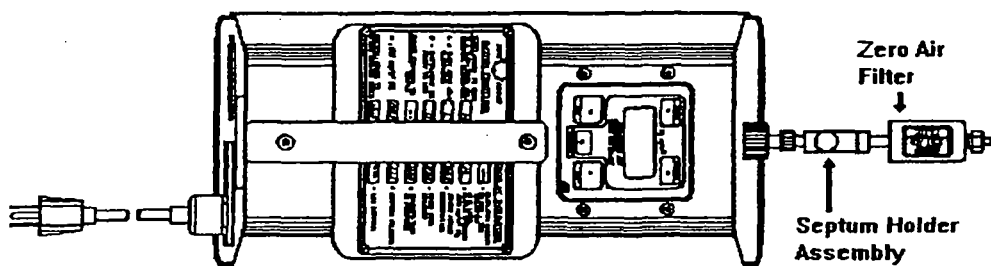
12.6 DILUTION MODULE RATIO CHECK

PROCEDURE:

NOTE: Wait a minimum of 30 minutes after a sensor regeneration before starting this procedure.

Direct 431-X Readings:

- ! Connect the instrument, septum holder assembly and zero air filter as shown in the figure below..

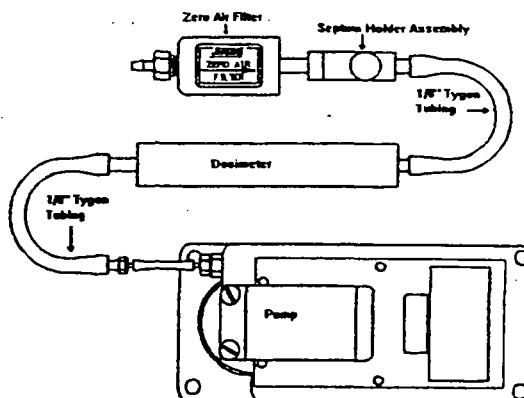


- ! Press the Jerome 431-X power ON button.
- ! Inject 1 cc of mercury saturated vapor into the septum, according to the Syringe Technique described on page 38 (431-X Functional Test, Appendix A).
- ! Make 3 additional 1 cc injections and record the digital meter readings (include the decimal points).
- ! Average the results of the last 3 injections.
- ! Remove the septum assembly and zero air filter from the instrument.

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12.7 MOST ACCURATE METHOD

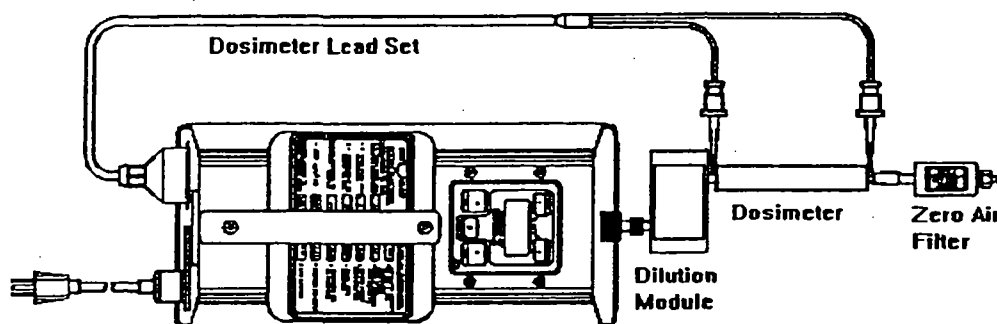
Perform the above test, however attach the dosimeter, septum holder assembly and zero air filter to the sampling pump that will be used. (See diagram.) Collection efficiencies should be approximately 100% up to 60 cc/min. If high flow rates are used, the final calculation should include this collection efficiency correction factor.



12.8 LOADING THE DOSIMETER

! Connect your pump, dosimeter, septum holder assembly and zero air filter (using 1/8" Tygon™ tubing) according to the figure at the right.

! Turn on the pump.



! Inject 1 cc of mercury vapor into the septum, ten times (total 10cc mercury vapor).

! Wait 30 seconds after the last injection, then turn off the pump.

! Remove the dosimeter, septum assembly and zero air filter from the pump.

! Connect the instrument, dilution module, dosimeter, zero air filter and dosimeter lead set as shown in the figure above.

! Attach the power cord to the 431-X and plug it into AC power.

AC power is required to heat the dosimeter.

! Press the Jerome 431-X power ON button and then press SAMPLE button.

The digital meter reading appears in 15 seconds.

! Record the digital meter reading (include decimal point). Wait 60 seconds, then press SAMPLE again and record this reading.

Repeating the heating process ensures complete release of mercury from the dosimeter coil.

! Add the two digital meter readings together.

The sum of the two digital meter readings is the figure you will use in your calculations and is referred to as the meter response.

! Repeat this procedure two more times.

! Average the three meter responses you obtained in this section.

12.9 DILUTION MODULE RATIO CALCULATIONS

! Multiply the average obtained in the **Direct 431-X Readings** procedure by 10 (this is the number of 1 cc injections).

! Divide the result obtained in step 1 (above) by the average obtained in the **Loading the Dosimeter** procedure.

! Use the result as the dilution module ratio in your dosimeter analysis.

EXAMPLE:

Direct 431-X readings

0.102 mg/m³

0.103 mg/m³

0.104 mg/m³

0.103 mg/m³ average

Loading the dosimeter

0.120 mg/m³

0.113 mg/m³

0.100 mg/m³

0.111 mg/m³

Step 1 (above)

$0.103 \text{ mg/m}^3 \times 10 = 1.030 \text{ mg/m}^3$

Step 2 (above)

$(1.030 \text{ mg/m}^3) / (0.111 \text{ mg/m}^3) = 9.4$

Dilution module ratio 9.4:1

NOTE: For normal applications a X8 to X12 ratio is recommended. If your ratio is not within this range, call Customer Service at 800-235-3360 for assistance.

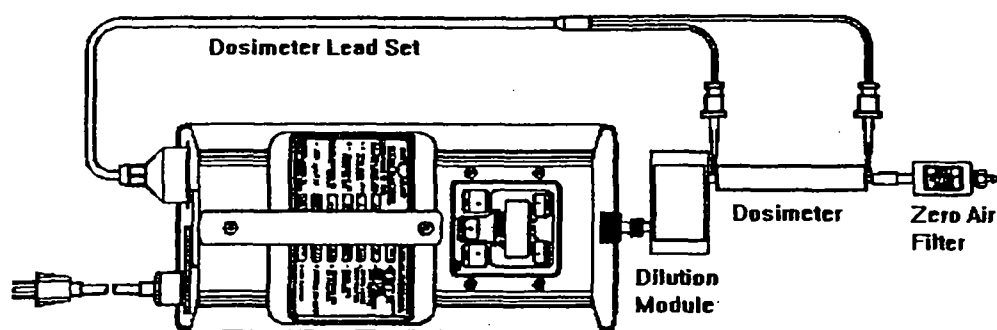
12.10 ANALYSIS WITH A DILUTION MODULE

PROCEDURE:

NOTE: Wait a minimum of 30 minutes after a sensor regeneration before starting this procedure.

! Connect the system as shown in the figure below.

! Attach the power cord to the 431-X and plug it into AC power.



AC power is required to heat the dosimeter.

- ! Press the Jerome 431-X power ON button and then press SAMPLE button. The digital meter reading appears in 12 seconds.
- ! Record the digital meter reading (include the decimal point). Wait 30 seconds, then press SAMPLE button again and record this reading.

Repeating the heating process ensures complete release of mercury from the dosimeter coil.

- ! Add the two digital meter readings together.

The sum of the two digital meter readings is the figure you will use in your calculations and is referred to as the meter response.

- ! You can perform the following calculation to obtain the mercury concentration in mg/m^3 based on a time weighted average.

Working Formula and Units of Measure
 $\text{Ng} \times \text{DM}/\text{SV} = \text{Sample Concentration}$

Alternately, DIP switch #2 can be set to OFF and the digital meter will display nanograms Hg directly.

MR (meter response)	total of the two digital meter readings in mg/m^3
87.5 $\text{ng}/\text{mg}/\text{m}^3$	conversion factor, a constant which changes the meter response to nanograms of Hg
DM dilution module ratio.....	the ratio determined on page 50
SV (sample volume).....	pump flow rate (in cc/min) multiplied by sample time (in minutes)
Sample concentration.....	$\text{ng}/\text{cc} = \text{mg}/\text{m}^3$

EXAMPLE:

(to calculate a time weighted average during an 8 hour period)

Meter response.....	0.600 mg/m^3 (sum of the two meter response readings)
Conversion factor.....	87.5 $\text{ng}/\text{mg}/\text{m}^3$ (constant)
Dilution module rate.....	9.4
Pump flow rate.....	2 cc/min
Sampling time.....	8 hours (480 min)
Sample volume.....	2 $\text{cc}/\text{min} \times 480 \text{ min} = 960\text{cc}$

$$(0.600 \text{ mg}/\text{m}^3 \times 87.5 \text{ ng}/\text{mg}/\text{m})/960\text{cc} = 0.055 \text{ ng}/\text{cc}$$

A. Convert the meter response (the total of the two digital meter readings) to nanograms of mercury.

The meter response multiplied by 87.5 (conversion factor) equals nanograms of mercury.

$$0.600 \times 87.5 = 52.5 \text{ nanograms of Hg}$$

B. Determine the actual mass of Hg collected by the dosimeter.

Nanograms of mercury times the dilution module ratio:

$$52.5 \text{ nanograms} \times 9.4 = 493.5 \text{ nanograms}$$

C. Determine the total volume of air sampled.

The pump flow rate times 60 min/hr times 8 hours

$$2 \text{ cc/min} \times 60 \text{ min/hr} \times 8 \text{ hr} = 960 \text{ cc}$$

D. Determine the Hg concentration (time weighted average) of the dosimeter.

The mass of Hg collected by the dosimeter divided by the total volume of air sampled.

$$493.5 \text{ nanograms} / 960 \text{ cc} = 0.0514 \text{ ng/cc of Hg} = 0.0514 \text{ mg/m}^3 \text{ of Hg}$$

! Check the sensor status after each dosimeter analysis.

IMPORTANT: Perform a sensor regeneration as soon as the meter display shows "----" (four bars) to prevent the loss of sample.

! Seal the dosimeter with tubing after analysis to prevent excessive mercury contamination during storage.

Dosimeter Reference Chart 431-X

Expected concentration, related to sample volume and meter response

Volume of air in mg/m³


431-X meter response

0.5	HL	HL	HL	HL	HL
0.1	0.274	0.549	HL	HL	HL
0.05	0.274	0.549	HL	HL	HL
0.025	0.069	0.274	HL	HL	HL
0.005	0.014	0.027	0.055	0.823	HL
0.001	0.003	0.005	0.011	0.016	0.329
	240	480	960	14,400	28,800

Volume of air in micrograms/m³ (.001 micrograms/m³ = 1 nanogram/m³)

431-X meter response

0.5	0.274	0.494	0.823	HL	HL	HL	HL
0.05	0.025	0.049	0.082	0.274	0.823	HL	HL
0.01	0.005	0.010	0.016	0.055	0.016	0.329	0.494
0.005	0.002	0.005	0.008	0.027	0.082	0.016	0.247
0.0005	0.000	0.000	0.001	0.003	0.008	0.016	0.025
	43,200	86,400	144,000	480,000	1,440,000	2,880,000	4,320,000

 = Indicates the optimum meter response for that concentration, with the corresponding volume

Relationship of flow rate and time to total sample volume

Total volume collected (cc/minute)

1000	60,000	120,000	240,000	480,000	720,000	1,440,000	2,880,000	4,320,000
100	6,000	12,000	24,000	48,000	72,000	144,000	288,000	432,000
60	3,600	7,200	14,400	28,800	43,200	86,400	172,800	259,200
20	1,200	2,400	4,800	9,600	14,400	28,800	57,600	86,400
10	600	1,200	2,400	4,800	7,200	14,400	28,800	43,200
2	120	240	480	960	1,440	2,880	5,760	8,640
	1	2	4	8	12	24	48	72
	Hours							

Use this formula for calculating the concentration of mercury in air:

$$\text{Concentration (mg/m}^3\text{)} = \frac{\text{Meter Response (x) 87.5 (a constant for the Jerome 431-X)}}{\text{Flow Rate of sampling pump (x) Time}}$$

13 APPENDIX C - INTERNAL DIP SWITCH SETTINGS

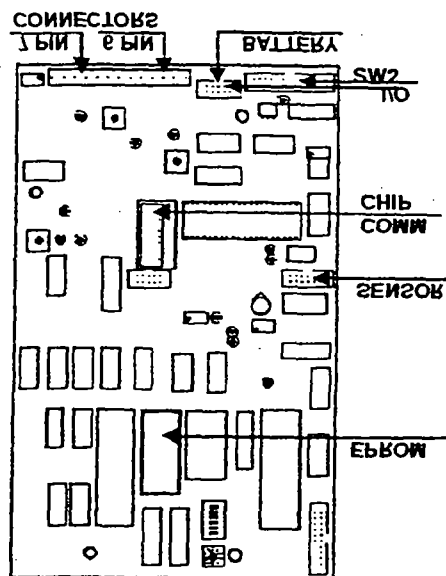
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Main (mother) board RED DIP switches (SW2)

This is the red DIP switch box located at the top, center of the instrument's main circuit board.

The 431-X provides regulated film heat at both 50 Hz and 60 Hz line frequencies. This also provides two ranges of preset but unregulated film heat (100-200/200-240 volt and 110-130/220-260 volt ranges). The preset film heats operate similarly to the old 431, but the two ranges are available to reduce the effects of chronic low or high line voltage.

Note: The ranges are doubled when the AC line selector switch is set to the 220V position. The DIP switch positions 1 and 6 must be properly set.



DIP 1	DIP 6	Function
OFF	OFF	60 Hz regulated film heat (100-130/200-260VAC)
OFF	ON	50 Hz regulated film heat (102-130/205-260 VAC)
ON	OFF	50/60 Hz preset film heat (110-130/220-260 VAC)
ON	ON	50/60 Hz preset film heat (100-120/200-240 VAC)

Regulated film heat should normally be used (DIP 1 OFF) except in the few cases where extremely dirty line voltage conditions may exist. These conditions might be found where large motors are being controlled or other situations may exist where the voltage may vary outside the 100-130 VAC range with regularity. In those cases the two preset heat ranges will allow some degree of satisfactory operation.

Switch Number	Normal Position	Action
2	ON	Nanograms mode
3	ON	Displays relative (not true) voltage during regen (0-255)
4	OFF	Display L-O-H when "zero" button pressed
	ON	Display 00-99 when "zero" button pressed
5	ON	Locks into 0-10mg/m ³ range (survey mode)

14 APPENDIX D - OPTION BOARD BLUE DIP SWITCHES

This is the blue DIP switch box located on the small (daughter) board mounted at the center of the main (mother) board.

Summary of blue DIP switch functions:

Switch	Function
1	Regeneration enable and time
2	Regeneration enable and time
3	Auto sample enable
4	Auto sample time
5	Auto sample time
6	DC power mode enabled (when ON and regeneration is started, this closes the relay on the data logger interface board to switch the inverter ON.

Timed Sensor Regeneration (Timed regeneration attempted one hour after start, then at interval.)

Switch #1	Switch #2	Regeneration Interval
Off	Off	Off
On	Off	6 hours
Off	On	24 hours
On	On	72 hours

Auto Sampling (Without JCI or data logger attached)

Switch #3	Switch #4	Switch #5	Sampling Frequency
On	On	On	No automatic sampling
Off	On	On	5 minutes
Off	Off	On	15 minutes
Off	On	Off	30 minutes
Off	Off	Off	1 hour

NOTE: Switch instrument power off before changing DIP switch settings.

15 APPENDIX E - OPTION BOARD MISCELLANEOUS TECHNICAL NOTES

15.1 INSTRUMENT ZEROING

The Jerome 431-X has essentially three zeros:

The instrument automatically rezeroes between samples and each sample is a unique reading. To take a sample, simply press the SAMPLE button.

The zero on the membrane switch is used to re-establish a baseline between the reference and sensor gold film after a sensor regeneration. This zero is manually adjusted by pressing the ZERO button and turning the potentiometer on the top of the instrument until the display reads 0. **Adjust only after sensor regeneration;** it is normal for H to be displayed after sampling.

The 431-X option board provides an auto zero feature that is invisible to the user. In some cases, the instrument does not resume sampling after a regeneration. At that time .L.L.L appears on the display when the ZERO button is pressed and the error message "manual bridge adjust needed" will be added to the notes column of the JCI text file if the JCI software is used. If this problem persists, it may be necessary to re-set the auto zero.

When necessary to re-adjust the auto zero point:

- ! Turn instrument off.
- ! Note original DIP switch settings.
- ! Turn DIP switch 4 on red DIP box to ON.
- ! Set the switches on the option board's blue DIP box to 1,2,6 OFF; 3,4,5 ON.
- ! Turn the instrument ON.
- ! Switch option board DIP #1 OFF and ON three times, leaving it ON.
- ! While pressing the ZERO button, turn the potentiometer on the option board until the numbers increase (maximum of 20). Note the display will flicker one digit.
- ! Return all switches to original position.

NOTE: The higher the auto zero number, the lower the capacity of the sensor and the more sensor regenerations are needed.

15.2 AUTOMATIC REGENERATION

The auto-regeneration should take place at the pre-configured time, with these exceptions: The instrument will always attempt a regeneration one hour after the SAMPLE button is pressed. The auto-regeneration will take place at the specified interval after that initial hour (for example, at hour 7, 13, 19, etc, if programmed for 6 hour auto-regeneration).

The instrument may NOT always perform the regeneration. The circuit forces the instrument towards 100% saturation to initiate the regeneration. If the sensor has not seen much mercury, the instrument will not auto-saturate. In this case, a regeneration will not take place. The instrument will always regenerate whenever the sensor is saturated. There should be no significant loss in sensitivity when a sensor auto-regeneration does not occur for 2-3 days.

Test this feature by initiating an auto-regeneration by turning the instrument ON and switching the daughter board's blue DIP switch #2 OFF and ON. If the line cord is plugged in, do not interrupt this regeneration cycle.

15.3 DC POWER MODE ENABLE

Instruments with the 431-X option board modification can be used with any +12 VDC source for continuous operation, if the AZI DC-AC power inverter kit is installed. The instrument requires 115 volts AC for regeneration. To preserve the life of the DC power source, the DC-AC inverter is switched on automatically for the regeneration only. The external switch on the inverter should always be OFF to preserve battery life during normal sampling.

When the instrument starts a regeneration and when DIP #6 is ON, the instrument sends a signal to close the relay on the 431-X data logger interface board mounted between the data logger and the instrument. This switches the inverter ON using the inverter's internal switch.

NOTE: When this mode is enabled, the instrument does NOT check for 115 VAC for the regeneration. If there is no AC power to the instrument, and a regeneration is initiated, the instrument will flash .H.H.H (rather than .P.P.P), however the sensor will not heat, nor will the sensor clean.

16 WARRANTY

Seller warrants to buyer that products delivered pursuant to this Agreement shall, at the time of delivery, and for a period of one (1) year thereafter (the Internal Battery Pack, where applicable, is warranted for a period of ninety [90] days only), be free from defects in material or workmanship and shall conform to seller's specifications or such other specifications as seller has agreed to in writing. Seller's obligations with respect to claims under this warranty shall be limited, at seller's option, either to the replacement of defective or non-conforming product or to an appropriate credit for the purchase price thereof subject to the provisions of seller's Warranty Policy as amended from time to time, said Policy being incorporated herein by reference.

Return products under warranty claims will be shipped to seller's plant by buyer at buyer's expense and shall be accompanied by a statement of the reason for the return and an approved Return Material Authorization Number issued by seller. Buyer remains responsible for payment for products not accepted for warranty adjustment and freight and handling costs associated therewith.

Notwithstanding the foregoing, no warranty shall be enforceable in the event that product has been subjected to environmental or stress testing by buyer or any third party without written approval of seller prior to such testing. Further, no warranty shall be enforceable if the alleged defect is found to have occurred as a result of misuse, neglect, improper installation, repair, alteration, accident, or improper return handling procedure by buyer.

Discontinued product is warranted only for a credit or replacement at seller's option.

THE EXPRESS WARRANTIES GRANTED ABOVE SHALL EXTEND DIRECTLY TO BUYER AND NOT TO BUYER'S CUSTOMERS, AGENTS, OR REPRESENTATIVES AND, EXCEPT FOR WARRANTY OF TITLE, IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND MERCHANTABILITY, SUCH OTHER WARRANTIES BEING SPECIFICALLY DISCLAIMED BY SELLER. IN NO EVENT SHALL EITHER PARTY'S LIABILITY FOR ANY BREACH OR ALLEGED BREACH OF THIS AGREEMENT EXCEED THE TOTAL EXTENDED PRICE OR PRICES SHOWN ON UNFILLED ORDERS, NOR SHALL EITHER PARTY BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM BREACH OR ALLEGED BREACH.

Notwithstanding the foregoing, if any product covered by order(s) placed hereunder is designated as "developmental" "prototype" or "experimental," no warranty whatsoever except a warranty of title to component materials, will be applicable thereto and buyer shall indemnify seller for any claims for liability asserted seller in connection therewith.

Medical Applications: Seller's products are not designed for use in medical appliances, devices or systems where malfunction of buyer's product can result in personal injury. Buyer's customers using or selling buyer's products for use in medical applications do so at their own risk and agree to fully indemnify buyer.

The foregoing state the entire liability of seller in connection with products supplied hereunder.

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Arizona Instrument Corporation

Jerome 431-X Mercury Vapor Analyzer Operation Manual

Part Number SS-086

Revision C

July, 1996

If you have any questions regarding the operation of this instrument, please call our toll free number (800) 235-3360. Internationally, call (602) 470-1414 or fax (602) 470-1888.

Arizona Instrument Corporation

4114 East Wood Street

Phoenix, Arizona 85040-1941 USA

<http://www.azic.com>

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APPENDIX B

**QUALITY ASSURANCE
CHECKLISTS**

**MERCURY SCREENING
RECORD FORM**



IT CORPORATION

A Member of The IT Group

**NICOR's Residential Mercury Response Project
Visual Survey Quality Assurance Review Checklist**

Inspection Supervisor: _____

Survey Team Member(s): _____

Date: _____

Property: _____

Observation Review: _____ Follow Up Review: _____

Outside Survey

	Yes	No
1. Did survey team properly determine presence/absence of outside meter?	_____	_____
2. Was presence/absence of Pin-off tee properly determined?	_____	_____
3. Was vent pipe properly searched for/identified?	_____	_____

Note any problems/issues: _____

Customer Access (complete for observation/ inquire for follow-up)

1. Did team attempt to see if residents were home?	_____	_____
2. Was team courteous to residents?	_____	_____
3. Did team properly identify itself to residents and explain its purpose?	_____	_____
4. If access could not be gained was reason properly documented?	_____	_____
5. If residents were not at home was appointment card left?	_____	_____
6. Did the team ask the customer the proper questions concerning the meter/house?	_____	_____

Note any problems/issues: _____

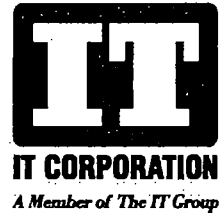
Meter/Service Visual Mercury Search

1. Were booties donned prior to entering assumed meter location?	_____	_____
2. Was an adequate search of location for old service entrance performed?	_____	_____
3. Did team look for visible mercury as described in procedure?	_____	_____
4. Was customer asked if mercury had ever been present and how it was removed?	_____	_____
5. If visible mercury was found, were booties immediately inspected for	_____	_____
6. contamination?	_____	_____
7. Was mercury suppressant placed over any visible mercury?	_____	_____
8. Was area with visible mercury evacuated/secured?	_____	_____
9. Was customer informed of actions and told that follow-up team will arrive?	_____	_____
10. Was use/occupancy of service area properly determined?	_____	_____
11. Was survey properly documented in accordance with procedure?	_____	_____
12. Was customer informed of survey result and told about impending screening?	_____	_____

Note any problems/issues: _____

Inspector signature: _____

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**NICOR's Residential Mercury Response Project
Mercury Screening Quality Assurance Review Checklist**

Inspection Supervisor: _____
Survey Team Member(s): _____
Date: _____
Property: _____
Instrument/Serial No.: _____ Cal. Due Date: _____
Observation Review: _____ Follow-up Review: _____

Instrument Parameters

	Yes	No
1. Was an instrument with current calibration/functional check records used?	_____	_____
2. Was instrument film heat/regen process performed at beginning of day?	_____	_____
3. Was instrument properly rebalanced before use?	_____	_____
4. Was instrument dust frit replaced prior to use for the day?	_____	_____
5. Was zero-filter background analysis properly performed/verified?	_____	_____

Note any problems/issues: _____

Customer Access(complete for observation/ inquire for follow-up)

1. Did team attempt to see if residents were home?	_____	_____
2. Was team courteous to residents?	_____	_____
3. Did team properly identify itself to residents and explain its purpose?	_____	_____
6. If access could not be gained was reason properly documented?	_____	_____
7. If residents were not at home was appointment card left?	_____	_____

Note any problems/issues: _____

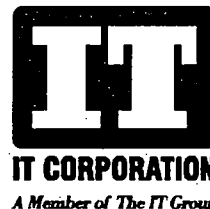
Mercury Screening

1. Was threshold test with zero-filter properly performed/documented <0.003mg/m ³ ?	_____	_____
2. All required areas/levels tested?	_____	_____
3. If reading >0.002 was reading repeated with zero-filter?	_____	_____
4. If still above 0.002 were potential interferences determined/documentated?	_____	_____
5. If readings above 0.002 w/o interference were all required areas screened?	_____	_____
6. Readings above 0.002 all playrooms and level bedrooms screened?	_____	_____
8. Area with readings >0.010 determined and isolated?	_____	_____
9. Readings fully documented?	_____	_____
10. Customer informed of readings and provided copies?	_____	_____
11. Was survey properly documented in accordance with procedure?	_____	_____

Note any problems/issues: _____

Inspector signature: _____

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**NICOR's Residential Mercury Response Project
Property Cleanup Quality Assurance Review Checklist**

Inspection Supervisor: _____
Survey Team Member(s): _____
Date: _____
Property: _____
Instrument/Serial No.: _____ Cal. Due Date: _____
Observation Review: _____ Follow-up Review: _____

Instrument Parameters

	Yes	No
1. Was an instrument with current calibration/functional check records used?	_____	_____
2. Was instrument film heat/regen process performed at beginning of day?	_____	_____
3. Was instrument properly rebalanced before use?	_____	_____
4. Was instrument dust frit replaced prior to use for the day?	_____	_____
5. Was zero-filter background analysis properly performed/verified?	_____	_____

Note any problems/issues: _____

Customer Access(complete for observation/ inquire for follow-up)

1. Did team attempt to see if residents were home?	_____	_____
2. Was team courteous to residents?	_____	_____
3. Did team properly identify itself to residents and explain its purpose?	_____	_____
6. If access could not be gained was reason properly documented?	_____	_____
7. If residents were not at home was appointment card left?	_____	_____

Note any problems/issues: _____

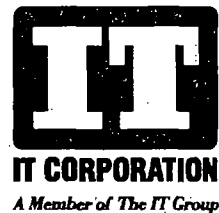
Cleanup Activities

1. Were previous screening/cleanup results available?	_____	_____
2. All required areas/levels tested?	_____	_____
3. Visible mercury collected?	_____	_____
4. Affected areas washed with extractant solution, rinsed, let dry, and vacuumed?	_____	_____
5. Items removed?	_____	_____
6. If so, were items cleaned and rescreened?	_____	_____
7. Items discarded?	_____	_____
8. Readings below 0.002 in affected areas?	_____	_____
9. Lumex screening for verification?	_____	_____
10. Readings fully documented?	_____	_____
11. Customer informed of readings and provided copies?	_____	_____
12. Was survey properly documented in accordance with procedure?	_____	_____

Note any problems/issues: _____

Inspector signature: _____

N0007728.2



**NICOR's Residential Mercury Response Project
Final Clearance Screening Quality Assurance Review Checklist**

Inspection Supervisor: _____
Survey Team Member(s): _____
Date: _____
Property: _____
Instrument/Serial No.: _____ Cal. Due Date: _____
Observation Review: _____ Follow-up Review: _____

Customer Access (complete for observation/inquire for follow-up)

- | | | |
|--|-------|-------|
| 1. Did team attempt to see if residents were home? | _____ | _____ |
| 2. Was team courteous to residents? | _____ | _____ |
| 3. Did team properly identify itself to residents and explain its purpose? | _____ | _____ |
| 3. If access could not be gained was reason properly documented? | _____ | _____ |
| 4. If residents were not at home was appointment card left? | _____ | _____ |

Note any problems/issues: _____

Lumex Screening (disregard if hopcalite testing done)

- | | Yes | No |
|---|-------|-------|
| 1. Was an instrument with current calibration/functional check records used? | _____ | _____ |
| 2. Was instrument fully charged at the beginning of day? | _____ | _____ |
| 3. Was instrument properly rezeroed before use? | _____ | _____ |
| 4. Was instrument dust frit replaced prior to use for the day? | _____ | _____ |
| 5. Was background analysis properly performed/verified? | _____ | _____ |
| 6. Was temperature raised to 85°F? | _____ | _____ |
| 7. All required areas/levels tested? | _____ | _____ |
| 8. If reading >0.002 were potential interferences determined/documentated? | _____ | _____ |
| 9. If readings above 0.002 w/o interference were all required areas screened? | _____ | _____ |
| 10. Area with readings >0.010 determined and isolated? | _____ | _____ |
| 11. Readings fully documented? | _____ | _____ |
| 12. Customer informed of readings and provided copies? | _____ | _____ |
| 13. Was survey properly documented in accordance with procedure? | _____ | _____ |

Note any problems/issues: _____

Hopcalite Testing (disregard if Lumex screening)

- | | | |
|---|-------|-------|
| 1. Was temperature raised to 85°F? | _____ | _____ |
| 2. Was field blank sampled along with 2 unopened blanks? | _____ | _____ |
| 3. Were at least 5 indoor sampling locations selected? | _____ | _____ |
| 4. Was floor map drawn with sampling locations noted? | _____ | _____ |
| 5. Were sampling pumps calibrated to 0.5 L/min? | _____ | _____ |
| 6. Samples taken for approximately 8 hours? | _____ | _____ |
| 7. Were periodic pump flow checks performed and documented? | _____ | _____ |
| 8. Chain-of-custody form prepared and used? | _____ | _____ |

Note any problems/issues: _____

Inspector signature: _____

N0007729.2



**NICOR's Residential Mercury Response Project
Property Screening Quality Assurance Review Checklist**

Inspection Supervisor: _____
Survey Team Member(s): _____
Date: _____
Property: _____
Observation Review: _____ Follow-up Review: _____

Elimination Criteria

- | | Yes | No |
|--|------------|-----------|
| 1. House was verified as being built after 1961.
(Houses built after 1961 were not equipped with mercury regulators).
Describe method of verification: _____
_____ | _____ | _____ |
| 2. The house was verified as having a meter with an old-style mercury
Regulator located outside the house. | _____ | _____ |
| 3. The house is currently located in NICOR's low-pressure distribution
System area or was converted from a low-pressure system after 1961.
Describe method of verification: _____
_____ | _____ | _____ |
| 4. A pin-off tee was verified as present outside of the house. | _____ | _____ |

Note any problems/issues: _____

Inspector signature: _____

N0007730 -2



MERCURY SCREENING RECORD

Date _____ Sample time _____ ☐ a.m. ☐ p.m. Meter No. _____

Customer contact name(s) _____

Home area code/phone no. _____ Work a/c and phone _____

Street address _____ City _____

Sampled by _____ Company: ☐ Nicor Gas ☐ Other _____Nicor Gas Contact Observing ☐ N/A ☐ Name _____Instrument type: ☐ Jerome ☐ Other _____ Serial No. _____ AM film heat performed ☐ Y ☐ NWindows open: ☐ Y ☐ N Heat on: ☐ Y ☐ N A/C on: ☐ Y ☐ NArrange for test by alternate method: ☐ Y ☐ N Potential for false positives: ☐ Y ☐ N

Initial test at threshold with zero filter; must have two consecutive readings registering as zero _____

Sample Location	Temp	Col. 1	Col. 2	Col. 3	Notes Such as Potential Interferences
		Initial Result (mg/m ³) If >.002, proceed to Col. 2	Result with zero filter	Follow-up result without zero filter	
First floor ambient – waist height					
Basement floor – at bottom step, 6 in. above floor					
Basement ambient – waist height					
At former regulator location – 6 in. above floor					
At former regulator location – waist height					
Inside closet / enclosure, if regulator was enclosed					
Additional sampling locations (identify each):					

☐ Y ☐ N Visible mercury detected Location _____☐ Y ☐ N Suppressant applied☐ Y ☐ N Additional visible mercury detected Location _____☐ Y ☐ N Additional suppressant applied☐ Y ☐ N Initial cleanup of suppressed mercury performed

Inspector signature: _____

N0007731.2

APPENDIX C

**STATISTICAL
DETERMINATION
OF SAMPLING SITES**

Memo



16406 U.S. Route 224 East, Findlay, Ohio 45840

Engineering Department

TO: Paul Lear, Ph. D.
FROM: John Carson, Ph. D.
PC: Rob Biolchini, Guy Gallelo
DATE: Thursday, October 12, 2000
SUBJECT: Mercury Inspection QA

QA Control and Accuracy Demonstration Strategy

IT will use a modified form of the sequential binomial test for control of clearance errors and verification of acceptably low error rates. In its guidance document Statistical Methods for Evaluating the Attainment of Superfund Cleanup Standards, USEPA [USEPA 1989] advocates the use of sequential hypothesis testing for the testing of percentiles and proportions. Sequential tests are discussed in great detail in Abraham Wald's book Sequential Analysis [Wald 1947] and in other books on sequential inference, such as [Siegmund 1985].

Broadly speaking, sequential tests share the following distinguishing characteristics:

- a statement (hypothesis) about some unknown condition which is to be either rejected or accepted based on observed data
- observations are taken in stages
- at each stage the data is evaluated and a decision is made to reject or accept the statement or to continue taking observations
- observations may be taken in groups, especially at the beginning of the process
- each decision is made based on all the observations taken up to that point
- the process is terminated by accepting or rejecting the statement when the value of the test statistic crosses a decision boundary
- the process may also be terminated after a certain number of observations have been taken, after which the statement is either rejected or accepted based on all the observations taken up to that point.

The sequential binomial test is a member of a class of sequential tests known as Sequential Probability Ratio tests (SPRT).

IT's modifications to the sequential binomial test procedure will be:

- the test statistic will be used as a quality indicator, so that observations will not be terminated until all inspections have been completed
- the test statistic passing the accept boundary at any time will be taken as strongly indicating

- the test statistic passing the accept boundary at any time will be taken as strongly indicating that clearance error rates are acceptably low
- three consecutive points moving closer to the fail decision boundary will trigger a corrective action investigation
- the test statistic passing the reject boundary at any time will be taken as strongly indicating the need for corrective action, including rechecking residences, retraining inspectors or releasing inspectors.

Surveillance Strategy

The figures in Attachment B show the 95 percent UCLs (under the binomial model) for the clearance error rate versus the total number of errors found for various percentages of inspections checked. It is obvious that in order to prove low error rates the total number of errors must be kept very low.

Each inspector will have one or more of his inspections QA checked for each day that he works. IT will use two surveillance modes: normal and enhanced. For an inspector under normal surveillance, the frequency of QA checking is one per day. For an inspector under enhanced surveillance, the frequency of QA checking is two per day. The normal rates are approximately 1 in 50 for a visual inspector and 1 in 30 for a Jerome inspector.

All inspectors will start under normal surveillance. A single detected clearance error by an inspector will put that inspector under enhanced surveillance for the next five days that he works. Another detected clearance error by that inspector will render him ineligible to conduct inspections. All work that has been performed by an inspector who has been disqualified must be checked.

Statement of Hypotheses and Error Rates

Let p denote the false clearance error rate for inspection. The hypotheses regarding the false clearance error rate for inspections are:

$$H_0 : p \leq p_0 \text{ versus } H_1 : p \geq p_1. \quad (1)$$

The default (or null) hypothesis H_0 is accepted unless there is sufficient evidence against it. The false positive probability (α) is the maximum probability of falsely rejecting H_0 when it is true. To ensure that enough data is collected to make a good decision, a specific alternative hypothesis H_1 is specified. The false negative probability (β) is the maximum probability of failing to reject H_0 when H_1 is true instead. While p is a false clearance error rate for the inspection process, α and β are overall error rates for the decision process to accept or reject H_0 . In this situation, α is the regulator's risk, and β is the client's risk. Smaller β requires more sampling.

The alternative, H_1 , is stated in terms of the typical formulation for assessing the power of a statistical test in a practical situation. This formulation emphasizes detecting a practical difference

from the null hypothesis with an acceptably high probability. USEPA's performance criterion for statistical tests used to assess attainment of cleanup is stated in just such terms [USEPA 1989].

More specifically, let p_V denote the false clearance error rate for visual inspection. This is the probability that a property that should be screened for mercury vapor is instead mistakenly determined to be "not involved" based on visual inspection. Let p_J denote the false clearance error rate for Jerome (mercury vapor) inspection. This is the probability that a property that should be remediated is mistakenly cleared by the instrument inspection.

IT proposes the following two sets of hypotheses for the visual and for Jerome (mercury vapor) inspections, respectively.

$$\begin{aligned} H_{V0} : p_V \leq p_{V0} = 0.01 \text{ versus } H_{V1} : p_V \geq p_{V1} = 0.02 \text{ and} \\ H_{J0} : p_J \leq p_{J0} = 0.005 \text{ versus } H_{J1} : p_J \geq p_{J1} = 0.01. \end{aligned} \quad (2)$$

Since the fraction of homes determined to be "not involved" after visual inspection is anticipated to be roughly 1/3, and since the probability of finding mercury contamination in homes inspected for mercury vapor is expected to be 5 percent or less, it is reasonable to view 0.01 (1 percent) as an acceptable clearance error rate for visual inspection. For the Jerome mercury analyzer inspection at locations with high pressure gas lines, IT believes that 0.005 (0.5 percent) approximates the lowest clearance error rate for mercury vapor inspections that can be reasonably achieved and reliably verified. IT further proposes that the error rates for the decision processes for both type of inspection (α_V , β_V , α_J , and β_J) be set to 0.05 (5 percent).

The estimated numbers for each type of inspection at the normal surveillance rates are $250,000 \times \frac{1}{3} \times \frac{1}{50} \approx 1667$ for the visual inspections and $250,000 \times \frac{1}{3} \times \frac{1}{30} \approx 5278$ for the Jerome inspections. These numbers are sufficient to satisfy the sample number requirements for conventional hypothesis testing using the normal approximation—1552 for the visual inspections and 3129 for the Jerome inspections—according to the statistical criteria proposed in the previous paragraph.

Binomial Model

Let X_1, X_2, X_3, \dots be a sequence of independently distributed binomial random variables with common probability of success p and varying number of independent trials n_1, n_2, n_3, \dots . Each of the X_i are sums of independent identically distributed (that is, with the same probability p of success) Bernoulli trials. Each Bernoulli trial is a simple event like a coin toss or a student passing or failing an exam. In this case, each QA check of an inspection is an independent Bernoulli trial.

We write $X_i \sim \text{Bin}(n_i, p)$, independent, $i = 1, 2, 3, \dots$, and

$$P(X_i = x | n_i, p) = \binom{n_i}{x} p^x (1-p)^{n_i-x}, 0 < p < 1, i = 1, 2, \dots, \quad (3)$$

with X_i being a count of successes. In this case, a “success” is a clearance error by an inspector that is detected in a QA check. Now n_i represents the number of QA checks of inspections on the i^{th} day, and X_i represents the number of clearance errors detected on the i^{th} day.

Implementation for Binomial Proportion

From Attachment A, we have for visual inspection surveillance

$$Z_{V,m} = \begin{cases} N_{V,m} \left\{ \hat{p}_{V,m} [-3.912 - \ln \hat{p}_{V,m}] + (1 - \hat{p}_{V,m}) [-0.0202 - \ln(1 - \hat{p}_{V,m})] \right\}, & \text{for } \hat{p}_{V,m} \leq 0.01 \\ N_{V,m} \left\{ 0.6931 \hat{p}_{V,m} - 0.01015 (1 - \hat{p}_{V,m}) \right\}, & \text{for } 0.01 < \hat{p}_{V,m} < 0.02 \\ N_{V,m} \left\{ \hat{p}_{V,m} [\ln \hat{p}_{V,m} + 4.605] + (1 - \hat{p}_{V,m}) [\ln(1 - \hat{p}_{V,m}) + 0.01005] \right\}, & \text{for } 0.02 \leq \hat{p}_{V,m} \end{cases} \quad (4)$$

where $\hat{p}_{V,m} = S_{V,m} / N_{V,m}$, $S_{V,m} = \sum_{i=1}^m x_{V,i}$, $N_{V,m} = \sum_{i=1}^m n_{V,i}$, and $n_{V,i}$ and $x_{V,i}$ represent, respectively, the number of visual inspections checked and the number of errors found on the i^{th} day.

Similarly, we have for the Jerome mercury vapor inspections

$$Z_{J,m} = \begin{cases} N_{J,m} \left\{ \hat{p}_{J,m} [-4.605 - \ln \hat{p}_{J,m}] + (1 - \hat{p}_{J,m}) [-0.01005 - \ln(1 - \hat{p}_{J,m})] \right\}, & \text{for } \hat{p}_{J,m} \leq 0.005 \\ N_{J,m} \left\{ 0.6931 \hat{p}_{J,m} - 0.005038 (1 - \hat{p}_{J,m}) \right\}, & \text{for } 0.005 < \hat{p}_{J,m} < 0.01 \\ N_{J,m} \left\{ \hat{p}_{J,m} [\ln \hat{p}_{J,m} + 5.298] + (1 - \hat{p}_{J,m}) [\ln(1 - \hat{p}_{J,m}) + 0.005013] \right\}, & \text{for } 0.01 \leq \hat{p}_{J,m} \end{cases} \quad (5)$$

Both $Z_{V,m}$ and $Z_{J,m}$ are charted against the limits 2.94 (reject boundary) and -2.94 (accept boundary).

Evaluating Distributional Assumptions

The SPRT for binomial proportions assumes that the X_i are independent binomial random variables with common probability parameter p . This requires that each of the X_i are sums of independent identically distributed Bernoulli trials. Each QA check of an inspection is an independent Bernoulli trial.

It is possible that some inspectors (or QA inspectors) are much better than average and some are much worse than average, so that the probability of clearance errors varies. This is a deviation from the binomial that would cause *underdispersion* relative to the binomial model, causing the binomial SPRT to have an effective error rates α and β smaller than the nominal rates and causing other statistical tests based on the binomial to be conservative.

On the other hand, if, due for instance to variable weather conditions, the probability of clearance

errors varied randomly from day to day, this would cause *overdispersion* relative to the binomial model and cause the binomial SPRT to have an effective error rates α and β larger than the nominal rates and cause other statistical tests based on the binomial to be anticonservative.

I will monitor for these conditions using the data from the daily QA checks of the inspections. The Beta Binomial model can handle underdispersion reasonably well. An alternative model that can handle both underdispersion and overdispersion is the Extended Beta Binomial model. If one of these models appears to be required, I can derive the SPRT for it in a day or less.

For the final data analyses at the end of inspections, I will probably use a logistic regression quasi-likelihood based model to allow a more detailed and robust analysis.

Glossary

False negative probability – the probability of accepting H_0 (rejecting H_1) when H_0 is really false

False positive probability – the probability of rejecting H_0 (accepting H_1) when H_0 is really true

$\ln(a)$ – natural logarithm of the number a .

Overdispersion – a situation that causes the sampling variance to be greater than predicted by the assumed probability model.

Probability density function – a non-negative function on the real number line that integrates to 1

Probability mass function – a non-negative function on a set of discrete values, like the non-negative integers or the set $\{0, 1, \dots, n\}$, that sums to 1

Probability distribution – a (left-continuous) non-decreasing function from the real number line to the interval $[0, 1]$ that takes the value 0 as its argument moves toward negative infinity and the value 1 as its argument moves toward positive infinity

Random variable – a mapping from a set of events, which have associated probabilities, to the real number line

Underdispersion – a situation that causes the sampling variance to be lower than predicted by the assumed probability model.

References

Bickel, P.J. and K.A. Doksum, 1977. Mathematical Statistics: Basic Ideas and Selected Topics. Holden-Day. San Francisco.

Govindarajulu, Z., 1981. The Sequential Statistical Analysis of Hypothesis Testing, Point and Interval Estimation, and Decision Theory. American Sciences Press. Columbus, Ohio.

Mood, A.M., F.A. Graybill and C.D. Boes, 1974. Introduction to the Theory of Statistics. McGraw-Hill. New York.

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Wald, A., 1947. Sequential Analysis. Wiley, New York.

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Attachment A

SPRT for Binomial Proportion

Notation

$\prod_{i=1}^n A_i = A_1 \cdot A_2 \cdots A_n$. This is the Π notation, which is used for the compact representation of a product.

$\sum_{i=1}^n A_i = A_1 + A_2 + \cdots + A_n$. This is the Σ notation, which is used for the compact representation of a sum.

Sequential Probability Ratio Test

Suppose we are given a sequence of independent *random variables* X_1, X_2, X_3, \dots . The random variables (X_i) may represent, for instance, concentrations of carcinogenic PAHs from a site or the number of exceedances of a threshold or failures of a process. Each X_i may have a common *probability density (or mass) function* which we will call f . Now suppose that f depends on a parameter θ , which takes on one of two values, θ_0 or θ_1 .

Further suppose that we want to determine whether the common probability density is f_0 (that is, $\theta = \theta_0$) or f_1 ($\theta = \theta_1$). If it is really f_0 , then $f_0(X_i) = f(X_i; \theta_0)$ will tend to be larger than $f_1(X_i) = f(X_i; \theta_1)$, and the ratio $L(X_i) = \frac{f_1(X_i)}{f_0(X_i)}$ will tend to be less than 1. If the common probability density is really f_1 , then the ratio L will tend to become greater than 1. In defining the statements or hypotheses to be tested, let H_0 represent the statement " f_0 is the common probability density function of X_1, X_2, X_3, \dots (that is, θ_0 is the correct parameter value)", and let H_1 represent the statement " f_1 is the common probability density (or mass) function of X_1, X_2, X_3, \dots (that is, θ_1 is the correct parameter value)". L is often referred to as a likelihood ratio because when $L > 1$, H_1 is regarded as being more likely to be true than H_0 .

The null hypothesis, H_0 , is accepted unless there is sufficient evidence to reject it in favor of the alternative hypothesis H_1 . A false positive decision, also known as a Type I error, is a decision to reject H_0 when H_0 is really true. A false negative decision, also known as a Type II error, is a decision to accept H_0 when H_0 is really false. The probabilities of committing Type I and Type II errors are denoted as α and β .

Define

$$L_m = L_m(X_1, X_2, \dots, X_m) = \prod_{i=1}^m L(X_i) = \prod_{i=1}^m \left[\frac{f_1(X_i)}{f_0(X_i)} \right] \quad (6)$$

(see the Notation section for an explanation of the Π notation). Then similarly, as m grows larger ($m \rightarrow \infty$), L_m tends toward 0 when H_0 is correct and toward infinity ($+\infty$) when H_1 is correct. Then we determine constants A and B ($A < B$) to serve as decision bounds, such that we decide to accept H_1 as true when $L_m \geq B$, to accept H_0 as true when $A \geq L_m$ and to continue sampling when

$A < L_n < B$. We must determine A and B so that the false positive probability (α) and the false negative probability (β) of the overall procedure, whenever it terminates, are held to specified levels. For convenience, we plot $Z_m = \ln L_m$ against m showing the decision boundaries $\ln(A)$ and $\ln(B)$.

Although the idea of evaluating the decision with each new observation is a very simple and beautiful idea, the problem of correctly specifying A and B , is mathematically very difficult and has only approximate solutions. Abraham Wald showed that for any SPRT, to a good approximation,

$$A \cong \frac{\beta}{1-\alpha} \text{ and } B \cong \frac{1-\alpha}{\beta}. \quad (7)$$

This is known as Wald's Approximation. For $\alpha = \beta = 0.05$, the corresponding values of A and B are $1/19$ and 19 . Then Z_m will be charted with the limits $\ln(1/19) = -2.94$ and $\ln(19) = 2.94$.

Now suppose that f depends on a parameter θ which takes values in an interval. Let $\theta_0 < \theta_1$. We may want to test the hypotheses $H_0 : \theta \leq \theta_0$ versus $H_1 : \theta \geq \theta_1$. These are composite hypotheses. The hypotheses stated in the previous paragraphs are simple hypotheses. Under certain conditions (which are satisfied for the binomial version given below), the SPRT construction given above will also work for the type of composite hypotheses given above with the modification that the denominator of L_m is replaced by

$$f_{m,0}^* = \max_{\theta \leq \theta_0} \left(\prod_{i=1}^m f(X_i; \theta) \right), \quad (8)$$

and the numerator is replaced by

$$f_{m,1}^* = \max_{\theta \geq \theta_1} \left(\prod_{i=1}^m f(X_i; \theta) \right). \quad (9)$$

Derivation of SPRT for Binomial Proportion

The binomial distribution with number of trials n and probability of success p , denoted by

$\text{Bin}(n, p)$, has distribution $P(X = x | n, p) = \binom{n}{x} p^x (1-p)^{n-x}$, $0 < p < 1$.

Let X_1, X_2, X_3, \dots be a sequence of independent $\text{Bin}(n_i, p)$ random variables with common probability of success. Let p_0 and p_1 be two values with $p_0 < p_1$. Let H_0 be the hypothesis that $p \leq p_0$, and let H_1 be the hypothesis that $p \geq p_1$.

For each positive integer m , define

$$f_{m,0}^* = \max_{p \leq p_0} \left(\prod_{i=1}^m \binom{n_i}{x_i} p^{x_i} (1-p)^{n_i-x_i} \right) \text{ and} \quad (10)$$

$$f_{m,1}^* = \max_{p \geq p_1} \left(\prod_{i=1}^m \binom{n_i}{x_i} p^{x_i} (1-p)^{n_i-x_i} \right). \quad (11)$$

It is easily shown that the expression on the right hand side (RHS) of Equation (10) attains its maximum at the parameter value

$$\hat{p}_{m,0} = \min(\hat{p}_m, p_0), \text{ where } \hat{p}_m = S_m / N_m, S_m = \sum_{i=1}^m x_i, \text{ and } N_m = \sum_{i=1}^m n_i.$$

Similarly, the expression on the RHS of Equation (11) attains its maximum at the parameter values $\hat{p}_{m,1} = \max(\hat{p}_m, p_1)$.

Then

$$f_{m,0}^* = \prod_{i=1}^m \binom{n_i}{x_i} \hat{p}_{m,0}^{x_i} (1 - \hat{p}_{m,0})^{n_i-x_i} = \left[\prod_{i=1}^m \binom{n_i}{x_i} \right] \hat{p}_{m,0}^{S_m} (1 - \hat{p}_{m,0})^{N_m-S_m}. \quad (12)$$

Similarly,

$$f_{m,1}^* = \prod_{i=1}^m \binom{n_i}{x_i} \hat{p}_{m,1}^{x_i} (1 - \hat{p}_{m,1})^{n_i-x_i} = \left[\prod_{i=1}^m \binom{n_i}{x_i} \right] \hat{p}_{m,1}^{S_m} (1 - \hat{p}_{m,1})^{N_m-S_m}. \quad (13)$$

Then

$$L_m = \frac{f_{m,1}^*}{f_{m,0}^*} = \frac{\hat{p}_{m,1}^{S_m} (1 - \hat{p}_{m,1})^{N_m-S_m}}{\hat{p}_{m,0}^{S_m} (1 - \hat{p}_{m,0})^{N_m-S_m}} = \begin{cases} \left(\frac{p_1}{\hat{p}_m} \right)^{S_m} \left(\frac{1-p_1}{1-\hat{p}_m} \right)^{N_m-S_m}, & \text{for } \hat{p}_m \leq p_0 \\ \left(\frac{p_1}{p_0} \right)^{S_m} \left(\frac{1-p_1}{1-p_0} \right)^{N_m-S_m}, & \text{for } p_0 < \hat{p}_m < p_1 \\ \left(\frac{\hat{p}_m}{p_0} \right)^{S_m} \left(\frac{1-\hat{p}_m}{1-p_0} \right)^{N_m-S_m}, & \text{for } p_1 \leq \hat{p}_m \end{cases} \quad (14)$$

Now, set $Z_m = \ln(L_m)$. Then

$$\begin{aligned} Z_m &= \begin{cases} S_m [\ln p_1 - \ln \hat{p}_m] + (N_m - S_m) [\ln(1-p_1) - \ln(1-\hat{p}_m)], & \text{for } \hat{p}_m \leq p_0 \\ S_m [\ln p_1 - \ln p_0] + (N_m - S_m) [\ln(1-p_1) - \ln(1-p_0)], & \text{for } p_0 < \hat{p}_m < p_1 \\ S_m [\ln \hat{p}_m - \ln p_0] + (N_m - S_m) [\ln(1-\hat{p}_m) - \ln(1-p_0)], & \text{for } p_1 \leq \hat{p}_m \end{cases} \\ &= \begin{cases} N_m \{ \hat{p}_m [\ln p_1 - \ln \hat{p}_m] + (1-\hat{p}_m) [\ln(1-p_1) - \ln(1-\hat{p}_m)] \}, & \text{for } \hat{p}_m \leq p_0 \\ N_m \{ \hat{p}_m [\ln p_1 - \ln p_0] + (1-\hat{p}_m) [\ln(1-p_1) - \ln(1-p_0)] \}, & \text{for } p_0 < \hat{p}_m < p_1 \\ N_m \{ \hat{p}_m [\ln \hat{p}_m - \ln p_0] + (1-\hat{p}_m) [\ln(1-\hat{p}_m) - \ln(1-p_0)] \}, & \text{for } p_1 \leq \hat{p}_m \end{cases} \end{aligned} \quad (15)$$

For the visual inspection surveillance this becomes

$$Z_{V,m} = \begin{cases} N_{V,m} \left\{ \hat{p}_{V,m} [-3.912 - \ln \hat{p}_{V,m}] + (1 - \hat{p}_{V,m}) [-0.0202 - \ln(1 - \hat{p}_{V,m})] \right\}, & \text{for } \hat{p}_{V,m} \leq 0.01 \\ N_{V,m} \left\{ 0.6931 \hat{p}_{V,m} - 0.01015(1 - \hat{p}_{V,m}) \right\}, & \text{for } 0.01 < \hat{p}_{V,m} < 0.02 \\ N_{V,m} \left\{ \hat{p}_{V,m} [\ln \hat{p}_{V,m} + 4.605] + (1 - \hat{p}_{V,m}) [\ln(1 - \hat{p}_{V,m}) + 0.01005] \right\}, & \text{for } 0.02 \leq \hat{p}_{V,m} \end{cases} \quad (16)$$

For the mercury vapor inspection surveillance this becomes

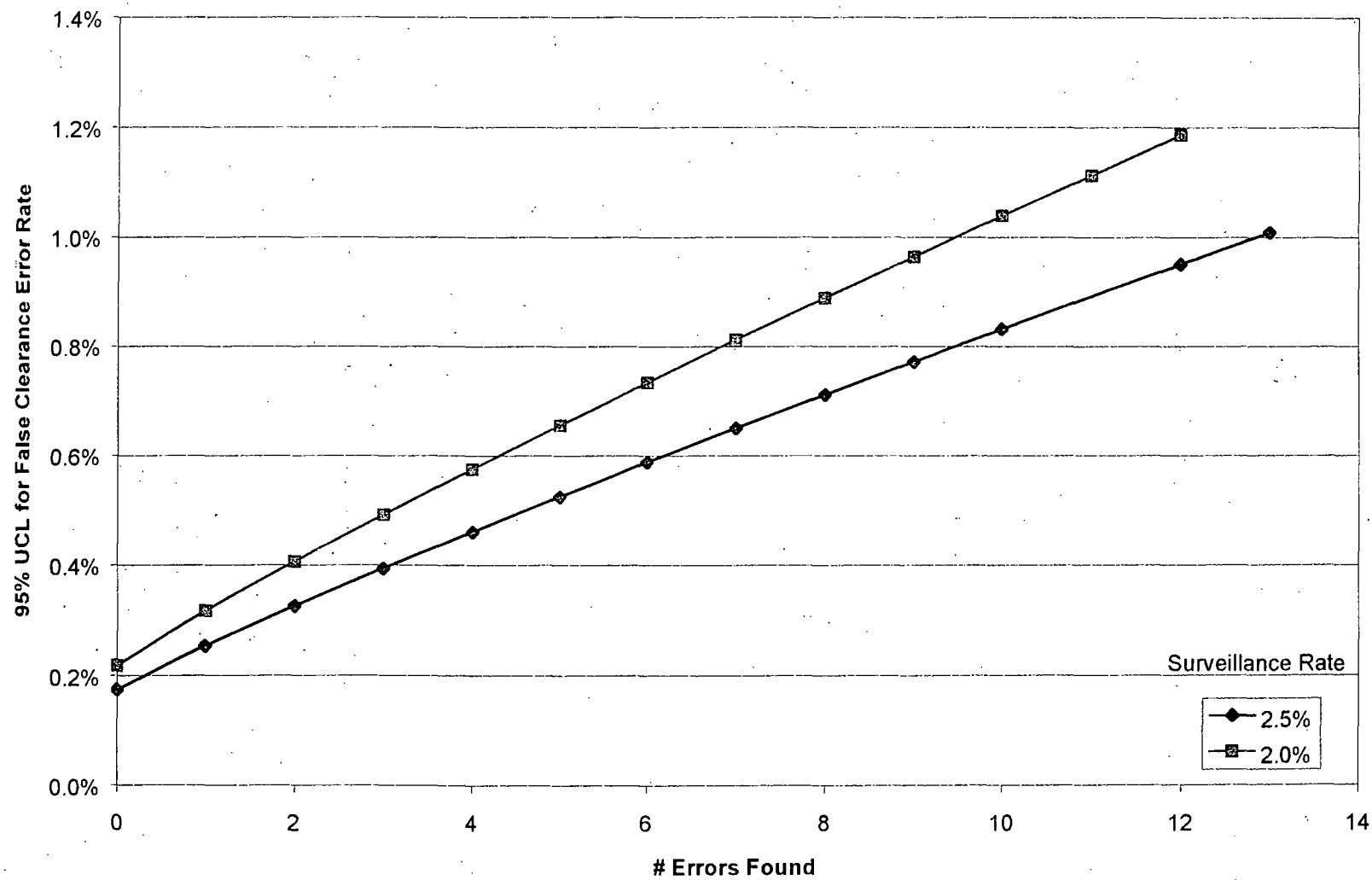
$$Z_{J,m} = \begin{cases} N_{J,m} \left\{ \hat{p}_{J,m} [-4.605 - \ln \hat{p}_{J,m}] + (1 - \hat{p}_{J,m}) [-0.01005 - \ln(1 - \hat{p}_{J,m})] \right\}, & \text{for } \hat{p}_{J,m} \leq 0.005 \\ N_{J,m} \left\{ 0.6931 \hat{p}_{J,m} - 0.005038(1 - \hat{p}_{J,m}) \right\}, & \text{for } 0.005 < \hat{p}_{J,m} < 0.01 \\ N_{J,m} \left\{ \hat{p}_{J,m} [\ln \hat{p}_{J,m} + 5.298] + (1 - \hat{p}_{J,m}) [\ln(1 - \hat{p}_{J,m}) + 0.005013] \right\}, & \text{for } 0.01 \leq \hat{p}_{J,m} \end{cases} \quad (17)$$

Both $Z_{V,m}$ and $Z_{J,m}$ are charted against the limits 2.94 (reject boundary) and -2.94 (accept boundary).

Attachment B

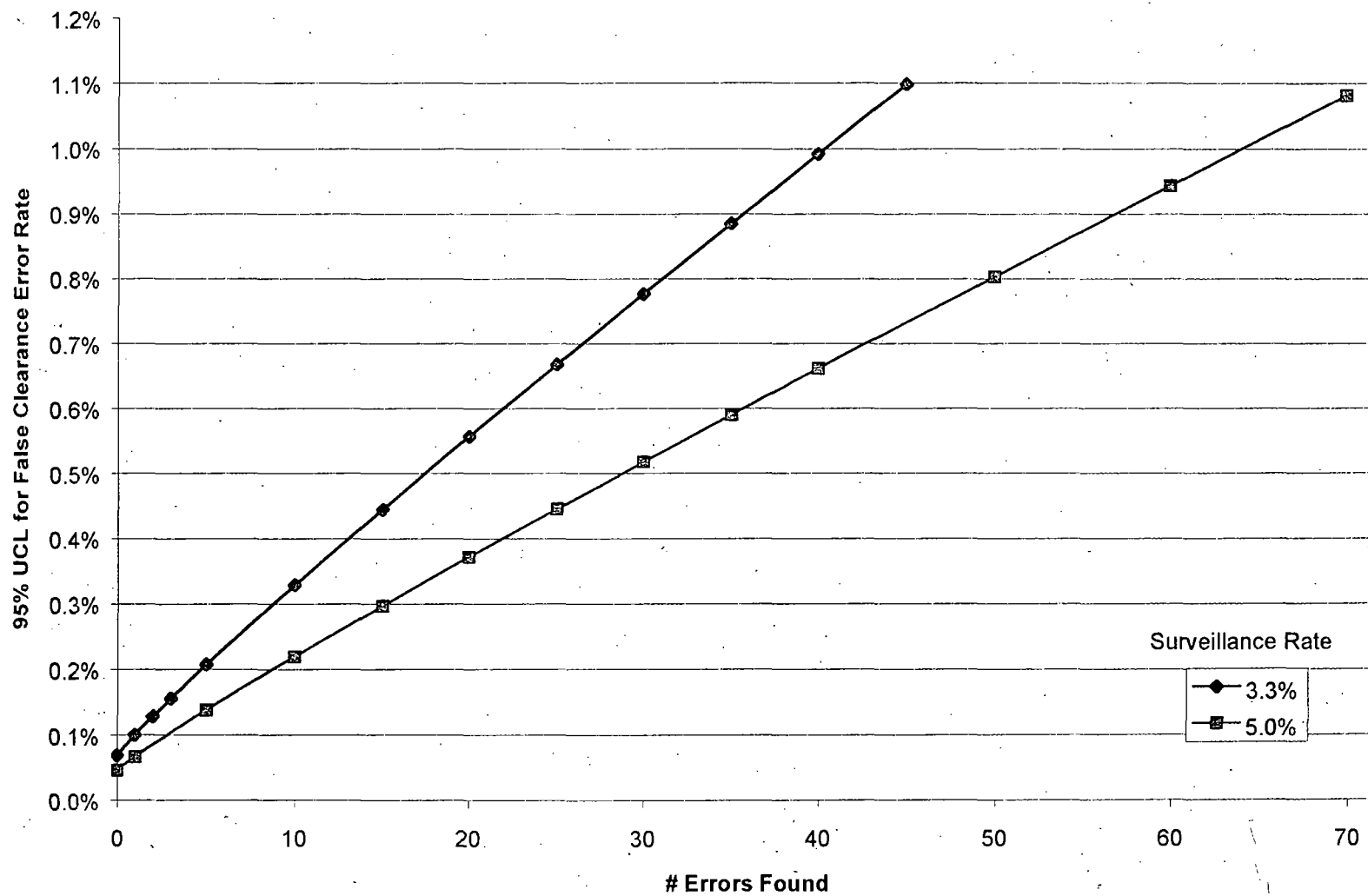
95 Percent UCLs for Clearance Error Rates Versus Number of Errors Detected for Various Surveillance Rates

Visual Inspection False Clearance Error Rate by Surveillance Rate



N0007743-2

Jerome Inspection False Clearance Error Rate by Surveillance Rate



Memo



INTERNATIONAL
TECHNOLOGY
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16406 U.S. Route 224 East, Findlay, Ohio 45840

Engineering Department

TO: Paul Lear

FROM: John Carson

PC: Rob Biolchini, Guy Gallelo

DATE: Friday, September 29, 2000

SUBJECT: Mercury Inspection QA

QA Control and Accuracy Demonstration Strategy

IT will use a modified form of the sequential binomial test for control of misclassification errors and verification of acceptably low error rates. In its guidance document Statistical Methods for Evaluating the Attainment of Superfund Cleanup Standards, USEPA [USEPA 1989] advocates the use of sequential hypothesis testing for the testing of percentiles and proportions. Sequential tests are discussed in great detail in Abraham Wald's book Sequential Analysis [Wald 1947] and in other books on sequential inference, such as [Siegmund 1985].

Broadly speaking, sequential tests share the following distinguishing characteristics:

- a statement (hypothesis) about some unknown condition which is to be either rejected or accepted based on observed data
- observations are taken in stages
- at each stage the data is evaluated and a decision is made to reject or accept the statement or to continue taking observations
- observations may be taken in groups, especially at the beginning of the process
- each decision is made based on all the observations taken up to that point
- the process is terminated by accepting or rejecting the statement when the value of the test statistic crosses a decision boundary
- the process may also be terminated after a certain number of observations have been taken, after which the statement is either rejected or accepted based on all the observations taken up to that point.

The sequential binomial test is a member of a class of sequential tests known as Sequential Probability Ratio tests (SPRT).

IT's modifications to the sequential binomial test procedure will be:

- the test statistic will be used as a quality indicator, so that observations will not be terminated

- until all inspections have been completed
- the test statistic passing the accept boundary at any time will be taken as strongly indicating that misclassification error rates are acceptably low
- three consecutive points moving closer to the fail decision boundary will trigger a corrective action investigation
- the test statistic passing the reject boundary at any time will be taken as strongly indicating the need for corrective action, including rechecking residences, retraining inspectors or releasing inspectors.

Surveillance Strategy

The first two figures in Attachment B show the 95% UCLs (under the binomial model) for the misclassification error rate versus the percentages of inspections checked and the total number of errors found. It is obvious that in order to prove low error rates the total number of errors must be kept very low.

Each inspector will have one or more of his inspections QA checked for each day that he works. IT will use two surveillance modes: normal and enhanced. For an inspector under normal surveillance, the frequency of QA checking is one per day. For an inspector under enhanced surveillance, the frequency of QA checking is two per day. The normal rates are approximately 1 in 50 for a visual inspector and 1 in 30 for a Jerome inspector.

All inspectors will start under normal surveillance. A single detected misclassification error by an inspector will put that inspector under enhanced surveillance for the next five days that he works. Another detected misclassification error by that inspector will render him ineligible to conduct inspections. All work that has been performed by an inspector who has been disqualified must be checked.

Notation

$\prod_{i=1}^n A_i = A_1 \cdot A_2 \cdots A_n$. This is the Π notation, which is used for the compact representation of a product.

$\sum_{i=1}^n A_i = A_1 + A_2 + \cdots + A_n$. This is the Σ notation, which is used for the compact representation of a sum.

Sequential Probability Ratio Test

Suppose we are given a sequence of independent *random variables* X_1, X_2, X_3, \dots . The random variables (X_i) may represent, for instance, concentrations of carcinogenic PAHs from a site or

the number of exceedances of a threshold or failures of a process. Each X_i may have a common probability distribution which we will call f . Now suppose that f depends on a parameter θ , which takes on one of two values, θ_0 or θ_1 .

Further suppose that we want to determine whether the common probability density is f_0 (that is, $\theta = \theta_0$) or f_1 ($\theta = \theta_1$). If it is really f_0 , then $f_0(X_i) = f(X_i; \theta_0)$ will tend to be larger than $f_1(X_i) = f(X_i; \theta_1)$, and the ratio $L(X_i) = f_1(X_i)/f_0(X_i)$ will tend to be less than 1. If the common probability density is really f_1 , then the ratio L will tend to become greater than 1. In defining the statements or hypotheses to be tested, let H_0 represent the statement " f_0 is the common probability density function of X_1, X_2, X_3, \dots (that is, θ_0 is the correct parameter value)", and let H_1 represent the statement " f_1 is the common probability density function of X_1, X_2, X_3, \dots (that is, θ_1 is the correct parameter value)". L is often referred to as a likelihood ratio because when $L > 1$, H_1 is regarded as being more likely to be true than H_0 .

The null hypothesis, H_0 , is accepted unless there is sufficient evidence to reject it in favor of the alternative hypothesis H_1 . A false positive decision, also known as a Type I error, is a decision to reject H_0 when H_0 is really true. A false negative decision, also known as a Type II error, is a decision to accept H_0 when H_0 is really false. The probabilities of committing Type I and Type II errors are denoted as α and β .

Define

$$L_m = L_m(X_1, X_2, \dots, X_m) = \prod_{i=1}^m L(X_i) = \prod_{i=1}^m \left[\frac{f_1(X_i)}{f_0(X_i)} \right] \quad (1)$$

(see the Notation section for an explanation of the Π notation). Then similarly, as m grows larger ($m \rightarrow \infty$), L_m tends toward 0 when H_0 is correct and toward infinity ($+\infty$) when H_1 is correct. Then we determine constants A and B ($A < B$) to serve as decision bounds, such that we decide to accept H_1 as true when $L_m \geq B$, to accept H_0 as true when $A \geq L_m$ and to continue sampling when $A < L_m < B$. We must determine A and B so that the false positive probability (α) and the false negative probability (β) of the overall procedure, whenever it terminates, are held to specified levels. For convenience, we plot $Z_m = \ln L_m$ against m showing the decision boundaries $\ln(A)$ and $\ln(B)$.

Although the idea of evaluating the decision with each new observation is a very simple and beautiful idea, the problem of correctly specifying A and B is mathematically very difficult and has only approximate solutions. Abraham Wald showed that for any SPRT, to a good approximation,

$$A \cong \frac{\beta}{1-\alpha} \text{ and } B \cong \frac{1-\beta}{\alpha}. \quad (2)$$

This is known as Wald's Approximation.

Now suppose that f depends on a parameter θ which takes values in an interval. Let $\theta_0 < \theta_1$. We may want to test the hypotheses $H_0: \theta \leq \theta_0$ versus $H_1: \theta \geq \theta_1$. These are composite hypotheses.

The hypotheses stated in the previous paragraphs are simple hypotheses. Under certain conditions (which are satisfied for the binomial version given below), the SPRT construction given above will also work for the type of composite hypotheses given above with the modification that the denominator of L_m is replaced by

$$f_{m,0}^* = \max_{\theta \leq \theta_0} \left(\prod_{i=1}^m f(X_i; \theta) \right) \quad (3)$$

and the numerator is replaced by

$$f_{m,1}^* = \max_{\theta \geq \theta_1} \left(\prod_{i=1}^m f(X_i; \theta) \right). \quad (4)$$

Statement of Hypotheses and Error Rates

The hypotheses are:

$$H_0 : p \leq p_0 \text{ versus } H_1 : p \geq p_1. \quad (5)$$

The alternative, H_1 , is stated in terms of the typical formulation for assessing the power of a statistical test in a practical situation. This formulation emphasizes detecting a practical difference from the null hypothesis with an acceptably high probability. USEPA's performance criterion for statistical tests used to assess attainment of cleanup is stated in just such terms [USEPA 1989].

For the visual inspection to classify gas lines as low or high pressure, IT proposes to use $p_0 = 0.01$ and $p_1 = 0.02$. For the Jerome mercury analyzer inspection at locations with high pressure gas lines, IT proposes to use $p_0 = 0.005$ and $p_1 = 0.01$.

The error rates α and β will be set to 0.05 (5 percent). The estimated numbers of each type of inspection are sufficient to satisfy the sample number requirements for conventional hypothesis testing that would satisfy the statistical criteria. The corresponding values of A and B will therefore be 1/19 and 19. Then Z_m will be charted with the limits - 2.94 and 2.94.

Implementation for Binomial Proportion

Let X_1, X_2, X_3, \dots be a sequence of independently distributed binomial random variables with common probability of success p and varying number of trials n_1, n_2, n_3, \dots . We write

$X_i \sim \text{Bin}(n_i, p)$, independent, $i = 1, 2, 3, \dots$, and

$$P(X = x | n, p) = \binom{n}{x} p^x (1-p)^{n-x}, \quad 0 < p < 1, \quad (6)$$

with X_i being a count of successes. In this case, a "success" is a classification error by an inspector that is detected in a QA check. Each X_i will represent the number of misclassifications

detected in a day.

Let p_0 and p_1 be two values with $p_0 < p_1$. Let H_0 be the hypothesis that $p \leq p_0$, and let H_1 be the hypothesis that $p \geq p_1$. It can be shown (see Attachment A) that in this case Z_m reduces to

$$Z_m = \begin{cases} S_m [\ln p_1 - \ln \hat{p}_m] + (N_m - S_m) [\ln(1 - p_1) - \ln(1 - \hat{p}_m)], & \text{for } \hat{p}_m \leq p_0 \\ S_m [\ln p_1 - \ln p_0] + (N_m - S_m) [\ln(1 - p_1) - \ln(1 - p_0)], & \text{for } p_0 < \hat{p}_m < p_1 \\ S_m [\ln \hat{p}_m - \ln p_0] + (N_m - S_m) [\ln(1 - \hat{p}_m) - \ln(1 - p_0)], & \text{for } p_1 \leq \hat{p}_m \end{cases} \quad (7)$$

Evaluating Distributional Assumptions

The SPRT for binomial proportions assumes that the X_i are independent binomial random variables with common probability parameter p . This requires that each of the X_i are sums of independent identically distributed (that is, with the same probability of success) Bernoulli trials. Each Bernoulli trial is a simple event like a coin toss or a student passing or failing an exam. In this case, each QA check of an inspection is a Bernoulli trial.

It is possible that some inspectors (or QA inspectors) are much better than average and some are much worse than average, so that the probability of detecting misclassification varies. This is a deviation from the binomial that would cause *underdispersion* relative to the binomial model, causing the binomial SPRT to have an effective error rates α and β smaller than the nominal rates and causing other statistical tests based on the binomial to be conservative.

On the other hand, if, due for instance to variable weather conditions, the probability of detecting misclassification varied randomly from day to day, this would cause *overdispersion* relative to the binomial model and cause the binomial SPRT to have an effective error rates α and β larger than the nominal rates and cause other statistical tests based on the binomial to be anticonservative.

If I am provided with the data on a daily basis, I will monitor for these conditions. The Beta Binomial model can handle underdispersion reasonably well. An alternative model that can handle both underdispersion and overdispersion is the Extended Beta Binomial model. If one of these models appears to be required, I can derive the SPRT for it in a day or less.

For the final data analyses at the end of inspections, I will probably use a logistic regression quasilielihood based model to allow a more detailed and robust analysis.

Glossary

False negative probability – the probability of accepting H_0 (rejecting H_1) when H_0 is really false

False positive probability – the probability of rejecting H_0 (accepting H_1) when H_0 is really true

$\ln(a)$ – natural logarithm of the number a .

Overdispersion – a situation that causes the sampling variance to be greater than predicted by the assumed probability model.

Probability distribution – a (left-continuous) non-decreasing function from the real number line to the interval $[0,1]$

Random variable – a mapping from a set of events, which have associated probabilities, to the real number line

Underdispersion – a situation that causes the sampling variance to be lower than predicted by the assumed probability model.

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Attachment A

Derivation of SPRT for Binomial Proportion

Derivation of SPRT for Binomial Proportion

The binomial distribution with number of trials n and probability of success p , denoted by

$\text{Bin}(n, p)$, has distribution $P(X = x | n, p) = \binom{n}{x} p^x (1-p)^{n-x}$, $0 < p < 1$.

Let X_1, X_2, X_3, \dots be a sequence of independent $\text{Bin}(n_i, p)$ random variables with common probability of success. Let p_0 and p_1 be two values with $p_0 < p_1$. Let H_0 be the hypothesis that $p \leq p_0$, and let H_1 be the hypothesis that $p \geq p_1$.

For each positive integer m , define

$$f_{m,0}^* = \max_{p \leq p_0} \left(\prod_{i=1}^m \binom{n_i}{x_i} p^{x_i} (1-p)^{n_i-x_i} \right) \text{ and} \quad (8)$$

$$f_{m,1}^* = \max_{p \geq p_1} \left(\prod_{i=1}^m \binom{n_i}{x_i} p^{x_i} (1-p)^{n_i-x_i} \right). \quad (9)$$

It is easily shown that the expression on the right hand side (RHS) of Equation (8) attains its maximum at the parameter value

$$\hat{p}_{m,0} = \min(\hat{p}_m, p_0), \text{ where } \hat{p}_m = \sum_{i=1}^m X_i / \sum_{i=1}^m n_i.$$

Similarly, the expression on the RHS of Equation (9) attains its maximum at the parameter values

$$\hat{p}_{m,1} = \max(\hat{p}_m, p_1).$$

Then

$$f_{m,0}^* = \prod_{i=1}^m \binom{n_i}{x_i} \hat{p}_{m,0}^{x_i} (1 - \hat{p}_{m,0})^{n_i - x_i} = \left[\prod_{i=1}^m \binom{n_i}{x_i} \right] \hat{p}_{m,0}^{S_m} (1 - \hat{p}_{m,0})^{N_m - S_m}, \quad (10)$$

where $S_m = \sum_{i=1}^m x_i$ and $N_m = \sum_{i=1}^m n_i$.

Similarly,

$$f_{m,1}^* = \prod_{i=1}^m \binom{n_i}{x_i} \hat{p}_{m,1}^{x_i} (1 - \hat{p}_{m,1})^{n_i - x_i} = \left[\prod_{i=1}^m \binom{n_i}{x_i} \right] \hat{p}_{m,1}^{S_m} (1 - \hat{p}_{m,1})^{N_m - S_m} \quad (11)$$

Then

$$L_m = \frac{f_{m,1}^*}{f_{m,0}^*} = \frac{\hat{p}_{m,1}^{S_m} (1 - \hat{p}_{m,1})^{N_m - S_m}}{\hat{p}_{m,0}^{S_m} (1 - \hat{p}_{m,0})^{N_m - S_m}} = \begin{cases} \left(\frac{p_1}{\hat{p}_m} \right)^{S_m} \left(\frac{1 - p_1}{1 - \hat{p}_m} \right)^{N_m - S_m}, & \text{for } \hat{p}_m \leq p_0 \\ \left(\frac{p_1}{p_0} \right)^{S_m} \left(\frac{1 - p_1}{1 - p_0} \right)^{N_m - S_m}, & \text{for } p_0 < \hat{p}_m < p_1 \\ \left(\frac{\hat{p}_m}{p_0} \right)^{S_m} \left(\frac{1 - \hat{p}_m}{1 - p_0} \right)^{N_m - S_m}, & \text{for } p_1 \leq \hat{p}_m \end{cases} \quad (12)$$

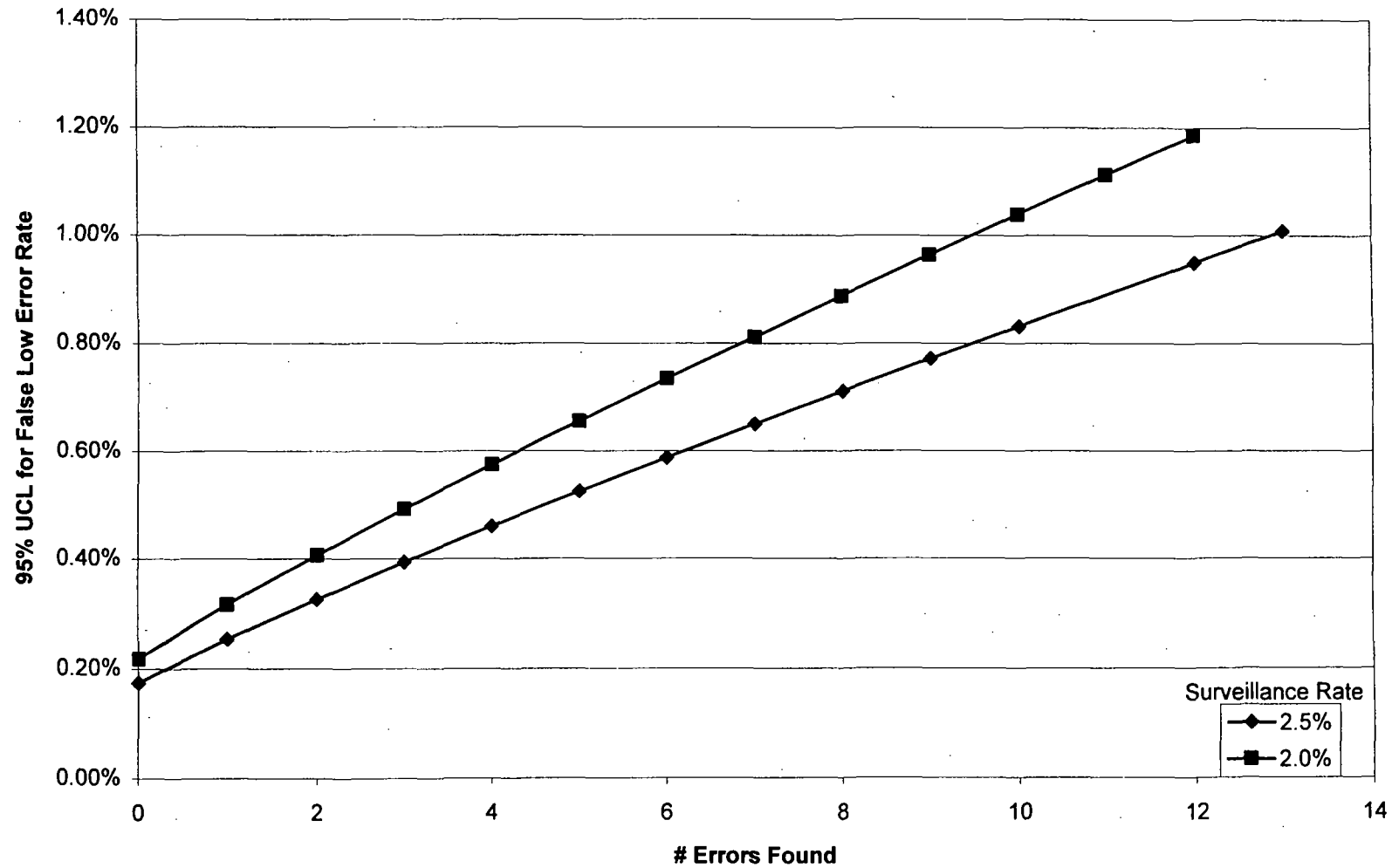
Now, set $Z_m = \ln(L_m)$. Then

$$Z_m = \begin{cases} S_m [\ln p_1 - \ln \hat{p}_m] + (N_m - S_m) [\ln(1 - p_1) - \ln(1 - \hat{p}_m)], & \text{for } \hat{p}_m \leq p_0 \\ S_m [\ln p_1 - \ln p_0] + (N_m - S_m) [\ln(1 - p_1) - \ln(1 - p_0)], & \text{for } p_0 < \hat{p}_m < p_1 \\ S_m [\ln \hat{p}_m - \ln p_0] + (N_m - S_m) [\ln(1 - \hat{p}_m) - \ln(1 - p_0)], & \text{for } p_1 \leq \hat{p}_m \end{cases} \quad (13)$$

Attachment B

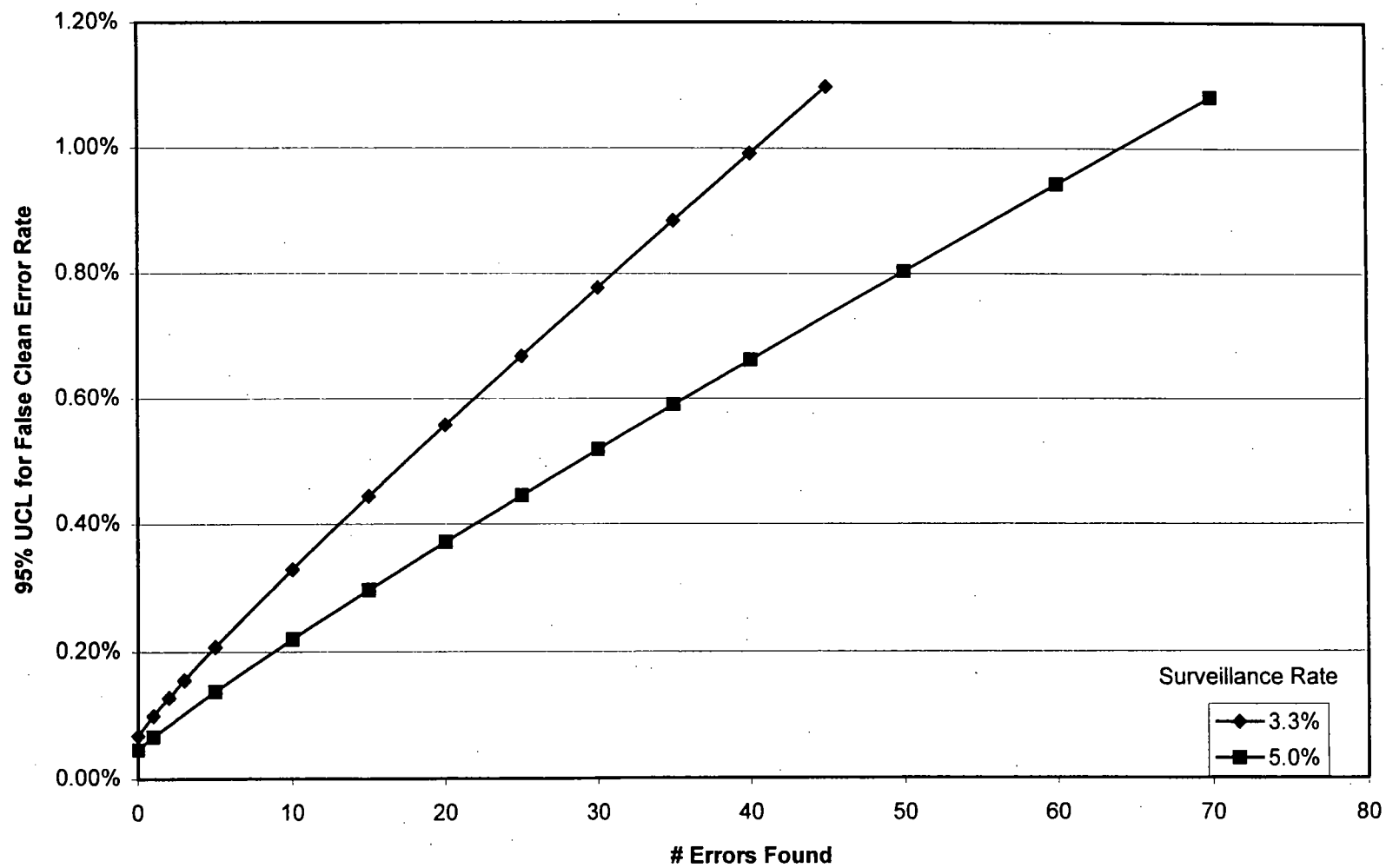
95% UCLs for Error Rates Versus Surveillance and Number of Errors Detected

Visual Inspection False Low Error Rate by Surveillance Rate



N0007743

Jerome Inspection False Clean Error Rate by Surveillance Rate



N0007744

Visual Inspection

Normal surveillance rate	2.0% (~ 1/30)												
# Errors	0	1	2	3	4	5	6	7	8	9	10	11	12
95% UCL for False Low Error Rate	0.22%	0.32%	0.41%	0.49%	0.57%	0.65%	0.73%	0.81%	0.89%	0.96%	1.04%	1.11%	1.19%

Partially enhanced surveillance rate	2.5%												
# Errors	0	1	2	3	4	5	6	7	8	9	10	12	13
95% UCL for False Low Error Rate	0.17%	0.25%	0.33%	0.39%	0.46%	0.52%	0.59%	0.65%	0.71%	0.77%	0.83%	0.95%	1.01%

Statistical Sample Number Requirrements

P0	0.01
P1	0.02
alpha	0.05
beta	0.05
Z(1-alpha)	1.644853
Z(1-beta)	1.644853
Nd	1552

N0007745

Jerome Inspection

Normal surveillance rate	3.3% (~ 1/30)												
# Errors	0	1	2	3	5	10	15	20	25	30	35	40	45
95% UCL for False Clean Error Rate	0.07%	0.10%	0.13%	0.16%	0.21%	0.33%	0.44%	0.56%	0.67%	0.78%	0.88%	0.99%	1.10%

Partially enhanced surveillance rate =	5.0%												
# Errors	0	1	5	10	15	20	25	30	35	40	50	60	70
95% UCL for False Clean Error Rate	0.05%	0.07%	0.14%	0.22%	0.30%	0.37%	0.45%	0.52%	0.59%	0.66%	0.80%	0.94%	1.08%

Statistical Sample Number Requirrements

P0	0.005
P1	0.01
alpha	0.05
beta	0.05
Z(1-alpha)	1.644853
Z(1-beta)	1.644853
Nd	3129

N0007746

250,000 homes
Visual inspection results in

	Total	Inspection fraction	Total Sample
low pressure regulators	83,333	0.020	1,667
high pressure regulators	166,667		
"Clean" fraction	0.95		
"Clean" high pressure reg.	158,334	0.034	5,386

Visual Inspection

100 inspectors	=	# of lots/day
50 homes/day/inspector	=	lot size
5000 homes/day/inspector	=	daily inspection
0.01 QA inspection fraction	=	sampling fraction
50 QA sample size	=	n
0 max acceptable errors	=	c
1.3% point of control	=	$P_{0.5}$

Jerome Inspection

100 inspectors	=	# of lots/day
30 homes/day/inspector	=	lot size
3000 homes/day/inspector	=	daily inspection
0.01 QA inspection fraction	=	sampling fraction
30 QA sample size	=	n
0 max acceptable errors	=	c
2.2% point of control	=	$P_{0.5}$

N0007747

N0007748



1.0 INTRODUCTION

This Health and Safety Plan (HASP) has been developed for the NICOR Mercury Project.

This HASP documents the policies and procedures which protect workers and the public from potential hazards posed by work at this site and is a key component in the **IT Safety Improvement Process**. IT considers safety the highest priority during work at a site containing potentially hazardous materials and has established a goal of **zero incidents** for all projects. All projects will be conducted in a manner that minimizes the probability of near misses, equipment/property damage, vehicle, or personal injury, etc. This HASP is a key element in the proper planning of project work, which is necessary to assure the goal of **zero incidents** is achieved. It will be reviewed prior to initiating each task listed in Section 1.2 and as often as may be necessary to provide for the health and safety of each site worker. The HASP Certification (Appendix A) will be signed by all that actively participate at this project.

Note: This Site Safety and Health Plan has been designed for the methods presently contemplated by IT Corporation (IT) for the execution of the proposed work. Therefore, this HASP may not be appropriate if the work is not performed using the methods presently contemplated by IT.

Although this plan focuses on the specific work activities planned for this program, it must remain flexible because of the nature of this work. Conditions may change and unforeseen situations may arise that require modifications from the original plan. Therefore IT only makes representations or warranties as to the adequacy of the HASP for currently anticipated activities and conditions. This flexibility allows modification by the IT supervisors and health and safety officials with approval from the Project Health and Safety Manager. All changes to procedures in this plan will be documented in writing using the form provided in Appendix B.

1.1 SITE HISTORY

Prior to 1961, meter sets using mercury containing regulators were installed in the homes of many NICOR customers. These regulators each contained up to 4 ounces of liquid mercury. Over the past 40 years, NICOR has been replacing the older mercury containing regulators located inside homes and commercial sites with non-mercury containing regulators located outside. During this replacement process, a small number of customer homes may have become impacted with mercury that had spilled during regulator installation, disconnection and removal.

1.2 SCOPE OF WORK

The principal tasks to be conducted are listed below.

- Property visual screening;
- Property instrument screening;
- Property Clean-up, and
- Property Final Clearance.

These activities have been analyzed for potential hazards for which control measures are provided in Section 3.5 Job Safety Analysis.

This HASP has been prepared for the above scope of work. Any changes to the scope of work will require amendment of the plan to remain approved. The Site Health and Safety Amendment Documentation form (Appendix B) will be used for all revisions/amendments to this plan.

2.0 KEY PERSONNEL

The Assistant Program Manager, Project Managers (PM), Supervisors, Project Certified Industrial Hygienist (CIH), and Site Safety Officers (SSO) share responsibilities for formulating and enforcing health and safety requirements, and implementing the HASP. This section outlines the responsibilities of each of these key personnel, IT Corporation employees and subcontractors.

2.1 PROJECT MANAGER (PM)

Each PM has overall responsibility for their sites and shall assure that the requirements of the contract are attained in a manner consistent with the HASP requirements. Each PM will coordinate with each of their Supervisors and SSOs to assure that the work is completed in a manner consistent with the HASP. Each PM will conduct a periodic health and safety review of their sites. Each PM reports to the Assistant Program Manager. Specific Key Requirement Areas (KRA's) for safety performance are listed in Table 2.1.

2.2 SITE SUPERVISOR (SS)

Each Supervisor is responsible for field implementation of the HASP and will function as primary SSO. Each Supervisor reports to a PM. Specific Key Requirement Areas (KRA's) for safety performance are listed in Table 2.1.

2.3 SITE SAFETY OFFICER (SSO)

Each SSO is authorized to administer the HASP. The SSO's primary operational responsibilities include personal and environmental monitoring, coordination of job safety analyses, selection and care of personal protective equipment, assignment of protection levels, review of work permits and observation of work activities. Each SSO is authorized to stop work when an imminent health or safety risk exists. Each SSO will assure that the essential safety requirements are communicated to all on-site personnel. Each SSO reports to the Project CIH. Specific KRAs for SSO performance include:

- Monitoring workers for signs of stress, such as cold exposure, heat stress, and fatigue.
- Reevaluating site conditions on an on-going basis. Coordinating protective measures including engineering controls, work practices and personal protective equipment.
- Assisting each Supervisor in the preparation, presentation and documentation of safety meetings.
- Conducting and preparing reports of daily safety inspections of work processes, site conditions, equipment conditions and submitting to each Supervisor. Discussing any necessary corrective actions with each Supervisor and reviewing new procedures.
- Initiating revisions of the HASP as necessary for new tasks or modifications of existing operations and submitting to the Project CIH for approval (see Appendix B).

- Reviewing air monitoring as required by the Site Specific Health and Safety Plan.
- Assisting each PM and Supervisor in incident investigations.
- Maintaining site safety records.
- Conducting periodic inspections of safety equipment
- Ensuring that project management/purchasing has pre-qualified sub contractors during the bidding stage. Informing subcontractors of the elements of the HASP/contractor pre-job safety checklist.
- Coordinating the preparation of Job Safety Analyses with the Supervisor, team leaders, and work crew
- Coordinating the daily Safety Observer Program (see Appendix J).
- Coordinating the Site Specific Safety Incentive Award Program (SIAP) with Assistant Program Manager.
- Coordinating the Site Safety Council on an as necessary basis.

**Table 2.1: Commercial Engineering & Construction Group
SAFETY IMPROVEMENT PROCESS 2000
KEY REQUIREMENT AREAS**

Key Requirement Areas (KRA's)	Key Personnel		
	Supervisors	Project Managers	Assistant Program Manager
Job Safety Analyses	Develop/Implement For each task	Assure/Review during site visits	Promote Use; Assure/Review forms during site visits
Safety Observation Program	Implement As Required (See Procedure)	Assure/Review during site visits	Promote Use; Assure/Review forms during site visits
HASP (HSO 52)	Implement	Request /Review	Assure/Review use during site visits
Incident Reports (HSO 20)	Obtain/Complete forms; Notify Key Personnel Submit forms to H/S Manager (See Flow Chart/Checklist)	Review/Sign forms; Participate in ARB*	Assure/Review; Sign ARB* forms
Site Safety Inspection Reports (HSO 21)	Complete 1 x/mo.; Submit to H/S Manager	Complete 1 x/mo. Submit to H/S Manager	Assure/Review forms during site visits
Safety Councils (HSO 18)	Implement on projects w ≥ 20 personnel & ≥ 60 days in duration (2 x/month)	Review/Participate in Project Safety Councils; Participate in Office/ Area Safety Councils (1 x/month)	Promote/Assure Project Safety Councils as required; Develop/Implement Area Safety Councils (1 x/month); Participate in Business Line (CE&CG) Safety Council (Every 2 months)
Safety Incentive Awards Programs (HSO 23)	Implement on all construction projects > 1 month continuous	Develop Programs; Sign forms/submit for approval	Promote/Assure Use; Approve Programs for Office SIAPs and Project SIAPs

* Accident Review Board

2.4 PROJECT CERTIFIED INDUSTRIAL HYGIENIST (CIH)

The Project CIH is responsible for reviewing the HASP and ensuring that the HASP is complete and accurate. The Project CIH provides technical and administrative support and will be available for consultation when required. If necessary, the CIH will direct modifications (Appendix B) to specific aspects of the HASP to adjust for on-site changes that affect safety. Each SSO will coordinate with the Project CIH on necessary modifications to the HASP. The Project CIH may make periodic site visits to determine compliance. The Project CIH reports to the Vice President, Health and Safety.

2.5 PERSONNEL SAFETY RESPONSIBILITIES

Each worker is responsible for personal safety as well as the safety of others in the work area and is expected to participate fully in the Safety Improvement Process, particularly the Safety Observation Program. The employee will use all equipment provided in a safe and responsible manner as directed by the SS. All IT personnel will follow the policies set forth in the IT Health and Safety Procedures Manual, with particular emphasis on the IT "Cardinal Safety Rules." Site personnel concerned with any aspect of health and safety shall bring it to the attention of the SS/SSO. If not satisfied, they should contact the Project CIH. All project personnel have the authority to stop work if in their judgement serious injury could result from continued activity. Each Supervisor and the SSO shall be notified immediately if this becomes necessary. To protect the health and safety of all personnel, employees that knowingly disregard safety policies/procedures may be subject to disciplinary actions.

Specific requirements include:

- Reading the HASP and any amendments prior to the start of on-site work.
- Providing documentation of medical surveillance and training to the SS/SSO prior to the start of work
- Attending the pre-work safety briefing prior to beginning on-site work as well as other scheduled safety meetings.
- Bringing forth any questions or concerns regarding the content of the HASP to the SS/SSO prior to the start of work.
- Reporting all potentially dangerous situations, incidents, injuries, and illnesses, regardless of their severity, to the SS/SSO.
- Complying with the requirements of this HASP and the requests of the SS/SSO.

2.6 SUBCONTRACTOR HEALTH AND SAFETY

This section of the HASP outlines general requirements for subcontractors including adoption the IT Corp. HASP, correction of safety violations and other general requirements.

2.6.1 Adoption of IT Corporation HASP

If a subcontractor of this project chooses to adopt IT Corporation's Health and Safety Plan, the subcontractor shall acknowledge this with the signature of a designated representative on a letter accepting the plan or on the "Subcontractor Health and Safety Plan Acknowledgement" form in Appendix A. The letter (or signed form) must be provided prior to that subcontractor's commencing work activities at the site. The subcontractor must make an independent determination of the applicability of IT's HASP to his/her work and must comply with all applicable statutes, federal, state and local regulations and codes. IT Corporation does not warrant that IT's plan will be sufficient for the subcontractor's work.

If the subcontractor adopts the IT HASP, this HASP becomes their responsibility to implement as it pertains to their work. The subcontractor assumes all liabilities for such adoption and implementation. All subcontractor personnel will read and sign the IT Corporation HASP.

If a subcontractor chooses to develop its own HASP, the subcontractor will provide a copy for IT to review within five (5) days of award of the subcontract or at least 5 days prior to commencement of work activities at the site, which ever occurs last. The subcontractor will insure his/her HASP will be in compliance with IT's HASP, all appropriate federal state and local regulations.

Each subcontractor will maintain a copy of the IT Corporation or their company HASP with each work crew and will be responsible for briefing each worker on the contents of this HASP as detailed in Section 9. The briefing will be documented on the form in Appendix A.

All subcontractor safety related incidents including near misses, shall be reported to the IT SS/SSO immediately.

2.6.2 Correction of Safety Violations

Every employer on the project has an obligation to prevent or correct hazards and to protect all employees from exposure to such conditions if they exist. To assure these obligations are being met, subcontractors will be subject to periodic inspection by IT Corporation. The subcontractor will be notified in writing if a safety violation is observed. The subcontractor shall have these violations corrected within the time frame noted and shall sign and enter the date on which the item was corrected and return the signed inspection reports so items can be rechecked. Failure to correct the violations and to return the signed inspection reports may result in termination of contract.

2.6.3 General Safety Requirements:

Additionally, each subcontractor is responsible for assuring the following:

- Designating a safety representative to work with the IT Corporation SSO.
- If applicable, issuing confined space entry permits, if necessary, to their employees and submitting copies to the SS/SSO for review. Performing all the necessary air monitoring to support confined space entry requirements
- Ensuring, via daily inspections, that all work conditions, practices and equipment are free of hazards
- Providing SS/SSO with copies of material safety data sheets (MSDS) for all hazardous materials brought on site.
- Providing all the required personal protective equipment for their employees.
- Providing daily safety instructions to their workers
- Reporting all safety incidents, including near misses, first aid, medical, equipment, vehicle, property and environmental to the IT SS/SSO, immediately.

2.7 KEY SAFETY PERSONNEL - PHONE NUMBERS

The following individuals share responsibility for health and safety for this program:

Program Manager:	Matt Radek
Operations Management:	Bob Driscoll 630-327-3918 (cell) Rob Weber 419-349-1085 (cell)
Inspection, Cleanup and Final Clearance Managers (Project Managers)	See Organization Chart
Cleanup Supervisors:	See Organization Chart
Director, Health and Safety/ Project CIH:	Kevin McMahon, M.S., CIH 609-588-6375 (office) 888-794-8304 (pager) pin # 7948304
Vice President, Health and Safety:	Warren Houseman, CIH 412-858-3917 (office)

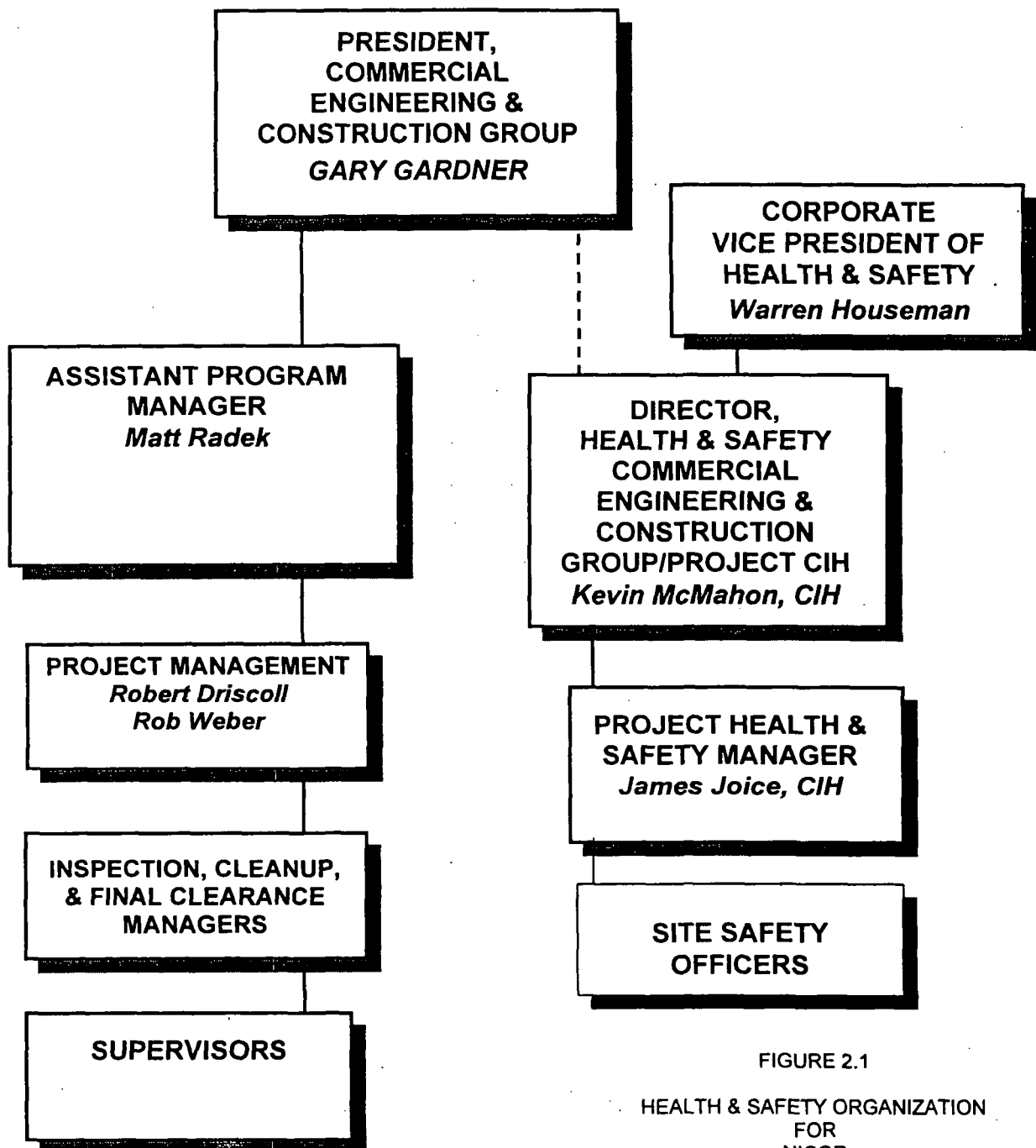


FIGURE 2.1

HEALTH & SAFETY ORGANIZATION
FOR
NICOR
MERCURY CLEAN-UP PROJECT

Prepared for:
NICOR
NAPERVILLE, IL

3.0 JOB SAFETY ANALYSIS

This section outlines the potential chemical and physical hazards which workers may be exposed to during work on this project. To date, mercury has been identified as the only chemical contaminant with potential for worker exposure. The assessment of chemical and physical hazards in this section is based on the review of project scope of work and historical information about the use of mercury in gas regulator. All operational chemicals are regulated by the OSHA Hazard Communication Standard. The written Hazard Communication Program covering these materials shall be followed and is included as Appendix D. MSDS' for chemicals which may be brought to the site are included in Appendix E.

3.1 CHEMICAL HAZARDS

Mercury, the primary chemical hazardous material of concern, presents potential health risks from both inhalation and skin contact. The following table presents the anticipated risk of mercury exposure during each of the major phases of work.

Work Phase	Anticipated Mercury Exposure Risk	
	Inhalation	Skin Contact
Property Visual Screening	Low	Low
Property Instrument Screening	Low	Low
Property Clean-up	Moderate to High	Moderate to High
Property Final Clearance	Low	Low

Mercury exposure occurs primarily through inhalation of mercury vapors but may also occur through direct skin contact. The skin absorption rate is far less significant and occurs at approximately 2% of the rate of absorption through the lungs. Ingestion of mercury poses little risk since little or no absorption occurs. Health effects associated with short-term exposure to high concentrations can cause respiratory damage, muscle weakness, headache, chest pain and difficulty breathing. Long term exposure to low concentrations is primarily associated with damage to the central nervous system, kidneys and the developing fetus. Early signs of exposure include weakness, fatigue, anorexia, weight loss and gastrointestinal problems.

The following general symptoms may indicate exposure to a hazardous chemical. Personnel will be removed from the work site and provided immediate medical attention if the following symptoms occur:

3.0 JOB SAFETY ANALYSIS

- Dizziness or stupor
- Nausea, headaches, or cramps
- Irritation of the eyes, nose, or throat
- Euphoria
- Chest pains and coughing
- Rashes or burns

3.1.1 Other Hazardous Materials

In the event that materials are encountered that are believed to be hazardous (such as asbestos, lead-containing materials, reactive materials, etc.), do not disturb the material. The Cleanup Quality Assurance Supervisor and a Site Safety Officer should be notified. The Project CIH will be notified if necessary.

3.2 PHYSICAL HAZARDS

To minimize physical hazards, standard safety protocols will be followed at all times. Failure to follow safety protocols will result in removal of the worker from the project. All personnel shall be familiar with the physical hazards presented by each of the tasks they perform. Task specific hazard analyses are provided in Section 3.4. These hazard analyses shall be reviewed prior to beginning each task and periodically throughout the task. It must be noted that these activity hazard analyses are general in nature. It is the responsibility of each SS to revise and adapt them as necessary to reflect site-specific conditions.

Each SS and SSO will observe the general work practices of each crew member and enforce safe procedures. Work areas will be inspected by the crew leaders, SS and SSO. All hazards will be corrected in a timely manner. A variety of physical hazards may be encountered during work activities at this site. Job Safety Analyses will be developed for each principal activity and will identify all major hazards to which employees may be exposed. Site-specific hazards and all necessary precautions will be discussed at the daily safety meetings.

3.2.1 Noise

Hearing protection is not anticipated for this project but will be required if the noise level is greater than 85 dBA (Time Weighted Average). The SSO will determine the need and appropriate testing procedures, (i.e., sound level meter and/or dosimeter) for noise measurement.

Action levels in the following table will trigger the use of appropriate hearing protection (plugs or muffs). Hearing protection must be able to attenuate noise below 90 dBA (8 hour TWA). Each hearing protection or device has a Noise Reduction Rating (NRR). The calculation for a hearing protection device's effectiveness is: Noise reading dBA - (NRR - 7dB) < 90 Dba.

3.0 JOB SAFETY ANALYSIS

Instrument	Measurement	Action
Type I or Type II Sound Level Meter or dosimeter	>80 dBA → 85 dBA	Hearing protection recommended. Limit work duration to 8-hour shifts.
	>85 dBA → 90 dBA	Hearing protection required. Limit work duration to 8-hour shifts.
	>90 dBA → 115 dBA	Hearing protection required. Investigate use of engineering controls. Limit work duration to 8 hour shifts.
	>115 dBA	Stop work. Consult Project CIH

3.4 VEHICLE SAFETY MANAGEMENT

3.4.1 Vehicle Safety

Motor vehicle incidents are the number one cause of occupational fatalities, accounting for one in three deaths. Fifty percent or more of vehicle safety incidents occur while backing up. IT employees involved in the operation and use of IT and/or leased or rented vehicles will comply with the *IT Motor Vehicle/Commercial Vehicle Operation and Maintenance Procedures* (HS800/810). IT requires employees to use seat belts at all times when traveling in IT owned or leased/rented vehicles. The SS and/or SSO will develop a parking area plan, including backing vehicles into parking spaces, using spotters for backing vehicles and policy mandated vehicle inspections.

Project personnel are expected to incorporate safe actions and preparations to avoid vehicle accidents and personal injury during work and off-hours. If parking areas are busy or crowded and more than one worker is traveling in the same vehicle, one worker should remain outside the vehicle as it leaves the parking space to assist the driver with traffic observation. Vehicles traveling before dawn and at dusk in rural or wooded areas should be prepared to brake for wildlife, e.g. deer crossing roadways.

IT employees are expected to use the vehicle inspection form and check/test the safety systems on the vehicle on a daily basis. Check the following: brakes, mirrors, seat belts, tires, leakage from the undercarriage, lights and turn signals. Vehicles with safety deficiencies must be reported immediately and not driven until properly repaired. Vehicles running errands from different project sites should have telephone numbers of the job site in the vehicle in case calls for assistance are required.

Because of the different ways alcohol can affect behavior, even in very small amounts, the best and safest course is not to drink before driving. At IT, a driver with blood alcohol concentration (BAC) over 0.04% is considered to be under the influence and subject to disciplinary action. Personnel involved in motor vehicle incidents are subject to drug and alcohol testing for reasonable cause or suspicion.

Weather conditions can have a profound effect on driving. On slippery roads, drive more slowly. Stop and turn with care. Keep several car lengths from other vehicles. At speeds in excess of 35 mph, the chances of hydroplaning increase with speed. In general, keep back 1 car length for every 10 mph to prevent striking the car ahead.

3.0 JOB SAFETY ANALYSIS

Vehicles will be operated in accordance with the requirements listed below:

- Seatbelt use is mandatory for all passengers;
- Personnel may not ride in the back of cargo vehicles;
- The driver must make a 360 degree walk around the assigned vehicle prior to vehicle movement;
- A ground guide is used to back up any vehicle;
- Vehicle speed is limited to the posted speed limits for developed roadways, 25 mph maximum on dirt roads and 10 mph maximum off-road (based on conditions);
- Vehicle driven in four wheel low and low gear when on dirt roads or off road driving where steep grades dictate;
- All operators must possess a valid drivers license;
- Fuel or gasoline are not transported inside the passenger compartment;
- No vehicle is left running when unattended; and
- Parking brakes are used when vehicles are parked.

In the event of a vehicle incident, notify your Site Supervisor *immediately* and complete all required reports.

3.5 TASK-SPECIFIC JOB SAFETY ANALYSES (JSA)

This section of the HASP provides a breakdown of the hazards and control measures for each principal task. The JSAs will be field checked by the supervisor on an ongoing basis and revised as necessary. All revisions will be communicated to the work crew.



Section 3.5 JSA Continued

JOB SAFETY ANALYSIS: VISUAL INSPECTION / INSTRUMENT INSPECTION / FINAL CLEARANCE TESTING				
Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing & Equipment	Monitoring Devices
Vehicle Use for Project Purposes	<ul style="list-style-type: none"> Collision with other vehicle, object, or pedestrian 	<ul style="list-style-type: none"> Wear seat belt Keep safe distance from other vehicle(s); use 2 second rule to control distance Obey speed limit/traffic rules Avoid distractions, e.g. cell phones, eating/drinking, reading map – stop/pull over to perform activities that may distract from attention to road Stay alert for children and pedestrians Have proper directions to site; take route free of known road hazards, e.g. construction, pot holes; congested traffic flow Maintain vehicle, e.g. tire pressure, fluid levels Keep head lights on for maximum visibility Perform 360 degree walk-around of vehicle to look for potential hazards/obstructions before pulling-out of parking spaces (back-in parking space if possible) Use a spotter if backing in/out of hazardous area, e.g. blind spot 	Seat Belt	"Dashboard" indicators
Arrive at Property / Customers' Home	<ul style="list-style-type: none"> Contact with local residents 	<ul style="list-style-type: none"> Avoid confrontation with local residents – leave area, call for assistance; use cell phone to call for emergency assistance 	Cell Phone	

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Section 3.5 JSA Continued

JOB SAFETY ANALYSIS: VISUAL INSPECTION / INSTRUMENT / FINAL CLEARANCE TESTING				
Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing & Equipment	Monitoring Devices
Arrive at Property / Customers' Home (continued)	<ul style="list-style-type: none"> Contact with wild animals/dogs 	<ul style="list-style-type: none"> Avoid wild animals – leave area, call for assistance if confronted Use animal repellant only in extreme emergency Report all bites and seek medical attention Avoid approaching residences with unrestrained dogs 	Cell Phone	
	<ul style="list-style-type: none"> Slips, Trips, Falls 	<ul style="list-style-type: none"> Use Walkways Be alert to irregular surfaces, ice hazards Walk carefully on uncleared walkways 		
Conduct Assessment	<ul style="list-style-type: none"> Animals 	<ul style="list-style-type: none"> Request home owner to restrain any problem pets Avoid angry animals – leave area Use animal repellant only in extreme emergency Report all bites and seek medical attention Know emergency numbers and route to hospital 		
	<ul style="list-style-type: none"> Slips, Trips, and Falls 	<ul style="list-style-type: none"> Be alert to stairway obstructions/tripping hazards Use flashlight if proper illumination is not available Avoid wet flooring surfaces 		
	<ul style="list-style-type: none"> Utility/Electrical Hazards 	<ul style="list-style-type: none"> Identify utility hazards in work area Avoid contact with electrical wiring 		
	<ul style="list-style-type: none"> Heavy objects 	<ul style="list-style-type: none"> Use proper lifting techniques Avoid manually lifting more than 60 lbs. Use drum cart to move drums 		

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Section 3.5 JSA Continued

JOB SAFETY ANALYSIS: VISUAL INSPECTION / INSTRUMENT INSPECTION / FINAL CLEARANCE TESTING				
Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing & Equipment	Monitoring Devices
Conduct Assessment (continued)		<ul style="list-style-type: none"> Get assistance from someone if mechanical lifting is not feasible 		
	<ul style="list-style-type: none"> Confined/restricted spaces 	<ul style="list-style-type: none"> Do not enter confined/restricted spaces until all hazards have been identified and assessed by trained/qualified personnel – Contact Project CIH 		
	<ul style="list-style-type: none"> Inhalation/contact with mercury/mercury vapor 	<ul style="list-style-type: none"> Review Material Safety Data Sheet (MSDS) to become familiar with hazardous properties of mercury and protective measures Monitor breathing zone air to determine mercury concentrations (Instrument Inspection) Wear appropriate skin and respiratory protection based on exposure levels (Instrument Inspection) 	Work clothes; booties; latex gloves for handling potentially contaminated materials; respirator if exceeded (See Section 7.0)	Jerome Model 411/431X

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Section 3.5 JSA Continued

JOB SAFETY ANALYSIS: PROPERTY CLEANUP

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Walls, Floors, Carpets, Furniture, etc.	Struck Against Protruding Objects	<ul style="list-style-type: none"> Review MSDSs for clean-up chemicals Wear hard hats, safety glasses with side shields, and steel-toe safety boots if performing structural repairs 	Hard hat, safety glasses, Steel-toe boots	
	Slips, Trips, Falls	<ul style="list-style-type: none"> Clear walkways, work areas of equipment, tools and debris Evaluate fall hazards above 4 ft.; use fall protection equipment (harness/lanyard), standard guardrails or other fall protection systems when working on elevated platforms above 6 ft. Use heavy duty industrial (type IA) ladders Tie-off all straight/extension ladders or manually hold by co-worker at base Exhibit caution when walking on wet surfaces 		
	Sharp Objects	<ul style="list-style-type: none"> Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects – use extra care when working near carpet tack-strips Maintain all hand and power tools in a safe condition Keep guards in place during use 	Leather gloves	
	Handling Heavy Objects	<ul style="list-style-type: none"> Observe proper lifting techniques Obey sensible lifting limits (60 lb. Maximum per person manual lifting) Avoid carrying heavy objects above shoulder level Avoid actions/activities that contribute to overexertion Warm up muscles before engaging in manual lifting activities Review lifting posture/techniques regularly at safety meetings 		
	Inhalation and Contact with Mercury and Other Hazardous Materials (e.g. cleanup products)	<ul style="list-style-type: none"> Provide workers proper skin, eye and respiratory protection based on the exposure hazards present Review hazardous properties of site contaminants and clean-up products before beginning work Monitor breathing zone air to determine mercury concentrations 	Tyvek coveralls, latex/nitrile gloves; air purifying respirator; latex boots	Jerome Model 411 or 431X; passive sampler

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Section 3.5 JSA Continued

JOB SAFETY ANALYSIS: PROPERTY CLEANUP

Task Breakdown	Potential Hazards	Critical Safety Practices	Personal Protective Clothing and Equipment	Monitoring Devices
Walls, Floors, (Continued)	Electrical Shock	<ul style="list-style-type: none">• Use double insulated or properly grounded electric power-operated tools use GFCIS.• Maintain tools in a safe condition• Inspect all extension cords daily for structural integrity, ground continuity, and damaged insulation• Keep all plugs and receptacles out of water• Use approved water-proof, weather-proof type if exposure to moisture is likely• Follow Lockout-Tagout procedures in accordance with IT Health and Safety Procedures # HS315		

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4.0 *WORK AND SUPPORT AREAS*

To prevent migration of contamination from personnel and equipment to clean areas, all work areas will be clearly identified using signs or physical barriers. The following work areas will be established at each site.

4.1 RESTRICTED AREA (RA)

The Restricted Area (RA) is the area suspected of contamination and presents the greatest potential for worker exposure. Personnel entering the area must wear the mandated level of protection for that area. In certain instances, different levels of protection will be required depending on the tasks and monitoring performed within that zone.

4.2 TRANSITION AREA (TA)

The Transition Area (TA) will be established between the RA and Clean Area (CA). In this area, personnel will begin the sequential decontamination process required to exit the RA. To prevent off-site migration of contamination and for personnel accountability, all personnel will enter and exit the RA through the TA. The TA for this project will be the access/egress routes to/from the RA and the personnel and equipment decontamination stations.

4.3 CLEAN AREA (CA)

The Clean Area (CA) serves as a clean, control area. Normal work clothing and support equipment are appropriate in this zone. Contaminated equipment, or clothing will not be allowed in the CA. There will be a clearly marked controlled access point from the CA into the TA and RA that is monitored closely to ensure proper safety protocols are followed.

4.4 GENERAL

The following items are requirements to protect the health and safety of workers and will be discussed in the safety briefing prior to initiating work.

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand to mouth transfer and ingestion of contamination is prohibited in the RA and TA.
- Hands and face must be washed upon leaving the RA and before eating, drinking, chewing gum or tobacco and smoking or other activities that may result in ingestion of contamination.
- No personnel will be permitted to work without the proper safety equipment, training, and medical surveillance certification.
- All personnel must comply with established safety procedures. Any worker who does not comply with safety policy, as established by the SSO or the SS, will be immediately dismissed from the site.
- Proper decontamination procedures must be followed before leaving the site.

5.0 PROTECTIVE EQUIPMENT

This section specifies the levels of personal protective equipment (PPE) which are or may be required for each principal activity performed at this site. All site personnel must be trained in the use of all PPE utilized.

5.1 ANTICIPATED PROTECTION LEVELS

The following protection levels have been established for the site work activities based on the information provided from the client, concerning the levels of site contaminants and the scope of work. Results of site air monitoring and visual inspections may indicate the need for changes in final PPE level(s). Changes in the initial PPE Levels prescribed in the Table below require completion of the HASP amendment form in Appendix B.

Task	Initial PPE Level	Upgrade PPE Level	Skin Protection	Respiratory Protection	Other PPE
Visual Screening	Level D	—	None	None	Work clothes; booties
Instrument Screening	Level D	—	None	None	Work clothes; booties latex gloves for handling potentially contaminated materials
Clean-up	Modified Level D	C	Tyvek Coveralls	<u>Initial:</u> None <u>Upgrade:</u> Full face air purifying respirator with mercury vapor cartridge	Hard-hat (for repair work); Steel-toe work boots (for repair work); leather gloves (for repair work) over latex/nitrile inner gloves; latex boots and hearing protection (>85 dBA)
Decontamination of Clean-up Equipment	Modified Level D	—	PVC rain suit or Tyvek coveralls	None	Hard-hat; Steel-toe work boots; latex gloves; latex boots and hearing protection (>85 dBA)
Final Clearance	Level D	—	None	None	Work Clothes

5.0 PROTECTIVE EQUIPMENT

5.2 PROTECTION LEVEL DESCRIPTIONS

This sections lists the minimum requirements for each protection level. Modification to these requirements may have been noted above.

5.2.1 Level D

Level D consists of the following:

- Work Clothes
- Booties
- Latex gloves (if handling contaminated materials)

5.2.2 Modified Level D

Modified Level D consists of the following:

- Safety glasses with side shields
- Hard hat (for repair work)
- Steel-toed work boots (for repair work)
- Latex booties
- Outer nitrile or leather gloves for repair work over nitrile/latex sample gloves
- Face shield (when projectiles or splashes pose a hazard)
- Tyvek coverall

5.2.3 Level C

Level C consists of the following:

- Full-face, air-purifying respirator with mercury vapor cartridges
- Tyvek coveralls
- Hard hat (for repair work)
- Steel-toed work boots (for repair work)
- Nitrile, neoprene, or latex overboots
- Nitrile, neoprene, or PVC gloves over latex sample gloves
- Face shield (when projectiles or splashes pose a hazard)

5.5 AIR-PURIFYING RESPIRATORS

A NIOSH approved full-face respirator with Mercury vapor cartridges will be used for level C work.

5.0 PROTECTIVE EQUIPMENT

5.6 RESPIRATOR CARTRIDGES

The crew members working in Level C will wear respirators equipped with approval for the following contaminants:

- Mercury Vapor

5.7 CARTRIDGE CHANGE-OUT SCHEDULE

All cartridges will be changed a minimum of once daily or as required by the cartridge end-of-life indicator – whichever is sooner. Each SS/SSO will review this requirement after monitoring the employee's breathing zone for mercury vapor and will revise this schedule as may be necessary to avoid over-exposure.

5.8 INSPECTION AND CLEANING

Respirators shall be checked periodically by a qualified individual and inspected before each use by the wearer. All respirators and associated equipment will be decontaminated and hygienically cleaned after each use.

5.9 FIT TESTING

Annual respirator fit tests are required of all personnel wearing negative-pressure respirators. The test will use isoamyl acetate or irritant smoke. The fit test must be for the style and size of the respirator to be used. Quantitative fit-testing is required for use of respirators in chemical environments where the respirator effective use limit exceeds 10 (exposure of 1 ppm inside the respirator for 10 ppm outside the respirator). Therefore, quantitative fit-testing is dependent on the PEL/TLV of the chemical substance involved. Quantitative fit-testing is required for potential exposure to air-borne particulate levels that exceed 10 times the established PEL/TLV.

5.10 FACIAL HAIR

No personnel who have facial hair which interferes with the respirator's sealing surface will be permitted to wear a respirator and will not be permitted to work in areas requiring respirator use.

5.11 CORRECTIVE LENSES

Normal eyeglasses cannot be worn under full-face respirators because the temple bars interfere with the respirator's sealing surfaces. For workers requiring corrective lenses, special spectacles designed for use with respirators will be provided. Use of contact lenses is permitted with full-face respirators based on a decision by the Occupational Safety and Health Administration (OSHA).

5.0 PROTECTIVE EQUIPMENT

5.12 MEDICAL CERTIFICATION

Only workers who have been certified by a physician, as being physically capable of respirator usage will be issued a respirator. Personnel unable to pass a respiratory fit test or without medical

clearance for respirator use will not be permitted to enter or work in areas on site that require respiratory protection.

5.13 SITE SPECIFIC PERSONAL PROTECTIVE EQUIPMENT (PPE) PROGRAM

The primary objective of the PPE program is to ensure employee protection and to prevent employee exposure to site contaminants during site operations. Engineering controls are not feasible for many tasks and, therefore, require the use of PPE.

The SS will be responsible for monitoring all aspects of the PPE program. This includes donning and doffing, temperature related stress monitoring, inspection, and decontamination (see Section 6.0). PPE selection is identified in Table 5.1 for each specified task. The SS in consultation with the SSO, and the Project CIH will direct changes in PPE based on changing conditions. The site specific HASP will serve as written certification that the workplace was evaluated concerning PPE requirements.

5.13.1 Site-Specific Respiratory Protection Program

The primary objective of respiratory protection is to prevent employee exposure to atmospheric contamination. When engineering measures to control contamination are not feasible, or while they are being implemented, personal respiratory protective devices will be used.

The criteria for determining respirator need have been evaluated based on the site contaminants; expected levels of protection are outlined in Section 5.1. Air monitoring will be conducted to confirm that respiratory protection levels are adequate (Section 7.0). All respirator users will be trained in proper respirator use and maintenance. The SS and SSO will observe workers during respirator use for signs of stress. The SS, SSO and Project CIH will also evaluate this HASP periodically to determine its continued effectiveness with regard to respiratory protection. All persons assigned to use respirators will have medical clearance to do so.

6.0 *DECONTAMINATION PROCEDURES*

This section describes the procedures necessary to ensure that both personnel and equipment are free from contamination when they leave the customer's home.

6.1 PERSONNEL DECONTAMINATION

During cleanup activities, decontamination procedures will ensure that material which workers may have contacted in the work area does not result in personal exposure and is not spread to clean areas of the site. This sequence describes the general decontamination procedures for Level D modified (D+), and Level C. The specific stages will vary depending on the site, the task, the protection level, etc. Dry decontamination may be used if there is insufficient space to support a full decontamination station as delineated with the steps below and approved by the SSO. The SS and the SSO will ensure that the decontamination procedures are adequate.

Level D+ Decontamination

1. Go to end of RA
2. Remove and discard latex booties
3. Remove outer gloves and discard
4. Cross into TA
5. Remove protective coverall
6. Remove inner sample gloves and discard
7. Wash face and hands

Level C Decontamination

1. Go to end of RA
2. Remove and discard latex booties
3. Remove outer gloves and discard
4. Remove protective coveralls
5. Remove outer sample gloves and discard
6. Cross into TA
7. Remove inner suit and discard, (if applicable)
8. Remove respirator
9. Remove inner sample gloves and discard
10. Wash face and hands



DECONTAMINATION PROCEDURES

6.1.1 Suspected Contamination

Any employee that is suspected of sustaining skin contact with chemical materials would wash the affected area with soap and water. The Project CIH will be notified and medical attention will be provided as determined by the degree of injury.

6.1.2 Personal Hygiene

Personnel will wash hands, arms, neck and face, following decontamination and before any eating, smoking, or drinking.

6.2 EQUIPMENT DECONTAMINATION

All contaminated equipment will be decontaminated before leaving the site. Decontamination procedures will be performed first using mercury vacuuming methods to remove all visible dust, followed by damp cloth or "tac" rag wipe-down. If required, wash fluids will be collected, containerized and sampled prior to disposal. Personnel performing this task will wear the proper PPE as prescribed by the SSO. (See workplan for further details).

6.3 DISPOSAL

All decontamination liquids and disposable clothing will be treated as contaminated waste unless determined otherwise by accepted testing methods. Wastes will be disposed according to state and federal regulations.

7.0 AIR MONITORING

Air monitoring will be conducted in order to characterize personnel exposures and fugitive emissions from site contaminants. Principal contaminants of concern are listed in Section 3.0 of this HASP. The target compounds selected for air monitoring purposes for this site include mercury vapor. Results of air monitoring will be used to ensure the proper selection of protective clothing and equipment, including respiratory protection, to protect on-site personnel and off-site receptors from exposure to unacceptable levels of site contaminants. Descriptions of air monitoring strategies, procedures and equipment are provided below. Modification of this plan, including additional monitoring, may be considered as judged necessary by the Project CIH, in conjunction with the SSO.

7.1 WORK AREA AIR MONITORING

Work area air monitoring of clean-up personnel will include direct reading methods as well as integrated sampling strategies.

7.1.1 Direct Reading Air Monitoring

During mercury clean-up activities, direct reading air monitoring will be performed in the work area to determine exposure to workers. A summary of air monitoring information is provided in the table below.

Monitoring Device	Monitoring Location/ Personnel	Monitoring Frequency	Action Level	Action
Direct reading mercury instruments or colorimetric mercury detector tubes	Clean-up personnel Inspection personnel	Minimum every 2 hours Minimum twice per day	<0.025 mg/m ³ ; < 0.10 mg/m ³ (15 min ceiling limit) >0.025 mg/m ³ <0.25 mg/m ³ ; >0.10 mg/m ³ (15 min ceiling limit) >0.25 mg/m ³	Level D Level C Stop work; consult Project CIH

7.1.2 Integrated Air Sampling

Representative integrated air sampling for personnel exposure characterization will be performed during clean-up activities. Samples will be collected on the most at risk cleanup personnel. Sampling will be conducted for mercury vapor following NIOSH 6009 or OSHA ID 140 (Appendix F). A summary of air monitoring information is given in the Table below. Following initial sampling, the project CIH will review results and determine if further sampling is necessary to characterize exposures.

Monitoring Device	Monitoring Location/ Personnel	Monitoring Frequency	Action Level	Action
Passive Sampler (SKC 520-02A & 520-03) or equivalent OSHA ID 140	Breathing Zone/Clean-up personnel	2 crews each day for first 14 days	<0.025 mg/m ³ (8 hr TWA); < 0.10 mg/m ³ (15 min ceiling limit) >0.025 mg/m ³ <0.25 mg/m ³ (8 hr TWA); >0.10 mg/m ³ (15 min ceiling limit) >0.25 mg/m ³ (TWA)	Level D Level C Stop work; consult Project CIH

7.4 INSTRUMENTATION

The following is a description of the air monitoring equipment to be used at this site.

7.4.5 Mercury Vapor Passive Monitor

7.4.5.1 Type and Operational Aspects

- The Passive Monitor is a carbon adsorbent element covered by a membrane through which air defuses at a standard rate.
- Volume of air sampled is then calculated as follows:
 - Defusion rate (liter/min.) x sample time (min.) = sample volume (liters)
 - Collection Media: charcoal element
- The carbon adsorbent element is uncovered and exposed to the air; that time becomes the start time and when the element is re-covered at the end of the day becomes that becomes the stop time. The number of minutes the element was exposed is then determined.

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7.4.5.2 Calibration Methods/Frequencies

The membrane of passive monitor has a fixed defusion rate and requires no calibration other than the recording of the time when the badge is opened and when the badge is closed.

7.4.5.3 Preventative Maintenance

The passive sampler needs no maintenance, however it must be inspected to determine if the defusion membrane is intact and free of defects and/or tears.

7.4.11 Mercury Vapor Analyzer

A mercury vapor analyzer (Jerome Mercury Vapor Analyzer 411/431X or equivalent) will be used to sample for mercury vapor in all work areas. It is designed to measure a concentration of 0.001 mg/m³ of mercury in air. Should the action level be exceeded during work operations PPE upgrades (see Section 5.0 HASP) will be implemented according to the tables in Sections 7.1.1 and 7.1.2 of this HASP. The NICOR Instrument Mercury Inspection Procedure-TT6049 shall be followed and be included as Appendix G.

7.4.11.1 Types and Operational Aspects

The Mercury Vapor Analyzer (MVA) operates by the absorption of mercury vapor by a thin gold film within the instrument. The absorption increases the electrical resistance in proportion to the mass of mercury in the sample. This change of resistance is displayed on the analog/LCD readout. The manufacturer recommends the heating or desorption of mercury vapor daily to keep the MVA operating at maximum efficiency.

7.4.11.2 Calibration Methods/Frequencies

Manufacturer specifications recommends a calibration check every 3 months or 20 hours of operation. Calibration requires the taking of a head space sample from a prepared sample of elemental mercury. The MVA, having being previously heated to clear the gold film, would then have the mercury introduced into the air flow with a syringe using the calibration accessories. A reading outside the acceptable range should be referred to the manual section on trouble shooting the device.

7.4.11.3 Preventative Maintenance

The Mercury Vapor Analyzer may become saturated if high concentrations are encountered. A light indicating saturation will appear on the analyzer. The analyzer must then undergo a period of purging before it can return to service. Purging involves heating the gold film sensor to desorb the mercury vapor, which is then absorbed by an activated carbon filter. Thus, the mercury is eliminated and cannot be re-detected giving a false positive reading.

Maintenance includes the changing of the battery and the various internal filter systems. The Manufacturer recommended change times include: intake filter disk, 20 hours or as needed; internal filter system, 3 months or as needed; charcoal filter annually.

The battery should be charged for sixteen hours after extended storage.

7.5 AIR MONITORING RECORDKEEPING

The SSO will ensure that all air-monitoring data is logged on the Direct Reading Air Monitoring Log and the Air Sampling Data Record (Appendix H). The IT Project CIH may periodically review this data.

7.6 CALIBRATION REQUIREMENTS

Mercury Vapor Analyzer will be calibrated daily before and after use. A log will be kept detailing date, time, span gas, or other standard, and name of person performing the calibration.

7.7 AIR MONITORING RESULTS

Air monitoring results will be communicated to personnel. Personal air sampling results will be forwarded to the Project CIH.

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8.0 *EMERGENCY RESPONSE AND CONTINGENCY PLAN*

8.1 PRE-EMERGENCY PLANNING

Prior to engaging in clean-up activities at the site, the SS will plan for possible emergency situations and have available adequate supplies and manpower to respond. In addition site personnel will be briefed concerning proper emergency response procedures.

The following situations would warrant implementation of the emergency plan:

Fire	<ul style="list-style-type: none">• The potential for human injury exists.• Toxic fumes or vapors are released.• The fire could spread on site or off site and possibly ignite other flammable materials or cause heat-induced explosions.• The use of water and/or chemical fire suppressants could result in contaminated run-off.• An imminent danger of explosion exists.
Spill or Release of Hazardous Materials	<ul style="list-style-type: none">• The spill could result in the release of flammable liquids or vapors, thus causing a fire or gas explosion hazard.• The spill could cause the release of toxic liquids or fumes in sufficient quantities or in a manner that is hazardous to or could endanger human health.
Medical Emergency	<ul style="list-style-type: none">• Overexposure to hazardous materials.• Trauma injuries (broken bones, severe lacerations/bleeding, burns).• Eye/skin contact with hazardous materials.• Loss of consciousness.• Heart attack.• Respiratory failure.• Allergic reaction.

The following measures will be taken to assure the availability of adequate equipment and manpower resources:

- Sufficient equipment and materials will be available and dedicated for emergencies only. The inventory will be replenished after each use.
- Emergency responders will be current in regards to training and medical surveillance programs. Copies of all applicable certificates will be kept on file for on-site personnel required to respond.

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EMERGENCY RESPONSE AND CONTINGENCY PLAN

- It will be the responsibility of the emergency coordinator to brief the on-site response team on anticipated hazards at the site. The emergency coordinator shall also be responsible for anticipating and requesting equipment that will be needed for response activities.
- Emergency response activities will be coordinated with the Local Emergency Management Agency (EMA) in compliance with SARA Title III requirements.

8.2 EMERGENCY RECOGNITION AND PREVENTION

Because unrecognized hazards may result in emergency incidents, it will be the responsibility of the SS and Site Safety Officer (SSO), through periodic site inspections and employee feedback (Safety Observation Program, daily safety meetings, and job safety analyses) to recognize and identify all hazards at the clean-up site. These may include:

Chemical Hazards	<ul style="list-style-type: none"> • Materials at the site (e.g. Mercury) • Materials brought to the site 	
Physical Hazards	<ul style="list-style-type: none"> • Fire • Slip/trip/fall • Vehicle traffic 	<ul style="list-style-type: none"> • Electrocution • Confined/restricted spaces
Mechanical Hazards	<ul style="list-style-type: none"> • Stored energy system • Electrical equipment 	<ul style="list-style-type: none"> • Vehicle traffic

Once a hazard has been recognized, the SS and/or the SSO will take immediate action to prevent the hazard from becoming an emergency. This may be accomplished by the following:

- Daily safety meeting
- Task-specific training prior to commencement of activity
- Lock-out/tag-out
- Personal Protective Equipment (PPE) selection/use
- Written and approved permits for hot work, confined space
- Air monitoring

EMERGENCY RESPONSE AND CONTINGENCY PLAN

**TABLE 8.1
EMERGENCY TELEPHONE NUMBERS**

<i>Local Agencies:</i>	
Emergency Medical Services	911
Fire Department	911
Police Department	911
Hospital –	To be determined by each work crew supervisor
Directions:	To be determined by each work crew supervisor
Agency for Toxic Substances and Disease Registry	404-639-0615 (24 hour)
National Response Center	800-424-8802
Director, Health and Safety / Project CIH – Kevin McMahon	609-588-6375 (office) 888-794-8304 (pager)
IT Transportation Spill Emergency Information (CHEM-TEL)	800-255-3924
IT Corporation Project Command Center	TBD

8.3 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATIONS

This section of the ERCP describes the various roles, responsibilities, and communication procedures that will be followed by personnel involved in emergency responses.

The emergency coordinators for this project are the the SSOs. The emergency coordinator will determine the nature of the emergency and take appropriate action as defined by this ERCP.

The emergency coordinator will implement the ERCP immediately as required. The decision to implement the plan will depend upon whether the actual incident threatens human health or the environment.

Immediately after being notified of an emergency incident, the emergency coordinator or his designee will evaluate the situation to determine the appropriate action.

8.3.1 Responsibilities and Duties

This section describes the responsibilities and duties assigned to the emergency coordinator.

It is recognized that the structure of the "Incident Command System" will change as additional response organizations are added. Personnel will follow procedures as directed by the fire department, LEPC, State and Federal Agencies as required. The SSO, in coordination with the local Fire Department chief will assume the role of Incident Commander. Additional on-site personnel may be added to the Site Emergency Response Team as required to respond effectively.



EMERGENCY RESPONSE AND CONTINGENCY PLAN

8.3.2 On-Site Emergency Coordinator Duties

The on-site emergency coordinator is responsible for implementing and directing the emergency procedures. All emergency personnel and their communications will be coordinated through the emergency coordinator. Specific duties are as follows:

- Identify the source and character of the incident, type and quantity of any release. Assess possible hazards to human health or the environment that may result directly from the problem or its control.
- Discontinue operations in the vicinity of the incident if necessary to ensure that fires, explosions, or spills do not recur or spread to other parts of the site. While operations are dormant, monitor for leaks, pressure build-up, gas generation, or ruptures in valves, pipes, or other equipment, where appropriate.
- Notify the Client Representative and local Emergency Response Teams if their help is necessary to control the incident. Table 8.1 provides telephone numbers for emergency assistance.
- Direct on-site personnel to control the incident until, if necessary, outside help arrives. Specifically:
- Ensure that the building or area where the incident occurred and the surrounding area are evacuated and shut off possible ignition sources, if appropriate. The Emergency Response Team is responsible for directing site personnel such that they avoid the area of the incident and leave emergency control procedures unobstructed.
- If fire or explosion is involved, notify local Fire Department.
- Have protected personnel, in appropriate PPE, on standby for rescue.

If the incident may threaten human health or the environment outside of the site, the emergency coordinator should immediately determine whether evacuation of area outside of the site may be necessary and, if so, notify the Police Department and the Office of Emergency Management.

When required, notify the National Response Center. The following information should be provided to the National Response Center:

- Name and telephone number
- Name and address of facility
- Time and type of incident
- Name and quantity of materials involved, if known
- Extent of injuries
- Possible hazards to human health or the environment outside of the facility.

EMERGENCY RESPONSE AND CONTINGENCY PLAN

The emergency telephone number for the National Response Center is 800-424-8802.

If hazardous waste has been released or produced through control of the incident, ensure that:

- Waste is collected and contained.
- Containers of waste are removed or isolated from the immediate site of the emergency.
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided.
- Ensure that no waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed.
- Ensure that all emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed.
- Notify the USEPA Regional Administrator that cleanup procedures have been completed and that all emergency equipment is fit for its intended use before resuming operations in the affected area of the facility. The USEPA Regional Administrator's telephone number is included in the Emergency Contacts.
- Record date, time, details of the incident, and submit a written report to the USEPA Regional Administrator. The report is due to the USEPA within 15 days of the incident.

8.4 EMERGENCY SPILL RESPONSE PROCEDURES AND EQUIPMENT

In the event of an emergency involving a hazardous material spill or release, the following general procedures will be used for rapid and safe response and control of the situation. Emergency contacts found in Table 8.1 provide a quick reference guide to follow in the event of a major spill.

8.4.1 Notification Procedures

If an employee discovers a chemical spill or release resulting in a vapor or material release, he or she will immediately notify the on-site emergency coordinator.

On-site Emergency Coordinator will obtain information pertaining to the following:

- The material spilled or released.
- Location of the release or spillage of hazardous material.
- An estimate of quantity released and the rate at which it is being released.
- The direction in which the spill, vapor or smoke release is heading.
- Any injuries involved.
- Fire and/or explosion or possibility of these events.
- The area and materials involved and the intensity of the fire or explosion.

This information will help the on-site emergency coordinator to assess the magnitude and potential seriousness of the spill or release.



EMERGENCY RESPONSE AND CONTINGENCY PLAN

8.4.2 Procedure for Containing/Collecting Spills

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If for some reason a chemical spill is not contained, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. Spills (less than or equal to 55 gallons) will require evacuation of at least 50 ft. in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area. If possible the area will be roped or otherwise blocked off.

If an incident may threaten the health or safety of the surrounding community, the public will be informed and possibly evacuated from the area. The on-site emergency coordinator will inform the proper agencies in the event this is necessary. (Refer to Table 8.1)

As called for in regulations developed under the Comprehensive Environmental Response Compensation Liability Act of 1980 (Superfund), a spill of a pound or more of any hazardous material for which a reportable quantity has not been established and which is listed under the Solid Waste Disposal Act, Clean Air Act, Clean Water Act, or TSCA shall be reported.

Clean up personnel will take the following measures:

- Make sure all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources, and use spark and explosion proof equipment for recovery of material.
- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- If wastes reach a storm sewer, try to dam the outfall by using sand, earth, sandbags, etc. If this is done, pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g. clay, sand, lime, etc.) to absorb discharged liquids.

For large spills, establish diking around leading edge of spill using booms, sand, clay or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank.

EMERGENCY RESPONSE AND CONTINGENCY PLAN

8.5 MEDICAL EMERGENCY

The procedures listed below will be used to respond to medical emergencies.

8.5.1 Response

The nearest workers will immediately assist a person who shows signs of medical distress or who is involved in an accident. The work crew supervisor will be summoned.

The work crew supervisor will immediately notify the on-site emergency coordinator to alert him of a medical emergency situation. The supervisor will advise the following information:

- Location of the victim at the work site
- Nature of the emergency
- Whether the victim is conscious
- Specific conditions contributing to the emergency, if known

The following actions will then be taken depending on the severity of the incident:

- *Life-Threatening Incident* – If an apparent life-threatening condition exists, the crew supervisor will inform the emergency coordinator, and the local Emergency Response Services (EMS) will be immediately called. An on-site person will be appointed who will meet the EMS and have him/her quickly taken to the victim. The injured person within the RA will be evacuated by site personnel to a clean area for treatment by (EMS) personnel.
- *Non Life-Threatening Incident* – If it is determined that no threat to life is present, the injured person will exit the RA and perform decontamination procedures appropriate to the nature of the illness or accident. Appropriate first aid or medical attention will then be administered.

**Note: The area surrounding an accident site must not be disturbed until the scene has been cleared by a Site Safety Officer.*

If decontamination can be performed, observe the following procedures:

- Wash external clothing and cut it away.

If decontamination cannot be performed, observe the following procedures:

- Wrap the victim in blankets or plastic to reduce contamination of other personnel.
- Alert emergency and off-site medical personnel to potential contamination, instruct them about specific decontamination procedures.
- Send site personnel familiar with the incident and chemical safety information, e.g. MSDS, with the affected person.

All injuries, no matter how small, will be reported to the SSO or the SS. An accident/injury/illness report will be completely and properly filled out and submitted to the Project CIH.

A list of emergency telephone numbers is given in Table 8.1.

EMERGENCY RESPONSE AND CONTINGENCY PLAN

8.5.2 Notification

The following personnel/agencies will be notified in the event of a medical emergency:

- Local Fire Department or EMS
- Project Manager
- Project CIH
- Client Representative

8.6 FIRE CONTINGENCY MEASURES

Because flammable/combustible materials are present at cleanup sites, fire is an ever-present hazard. IT personnel and subcontractors are not trained professional firefighters. Therefore, if there is any doubt that a fire can be quickly contained and extinguished, personnel will notify the emergency coordinator and vacate the structure or area. The crew supervisor will immediately notify the local Fire Department.

The following procedures will be used to prevent the possibility of fires and resulting injuries:

- Sources of ignition will be kept away from where flammable materials are handled or stored.
- Fire extinguishers will be placed in all areas where a fire hazard may exist.

8.6.1 Response

The following procedures will be used in the event of a fire:

- Anyone who sees a fire will notify the crew supervisor who will then contact the local Fire Department.
- When the emergency siren sounds, workers will disconnect electrical equipment in use (if possible) and proceed to the nearest exit.
- When a worker has extinguished a small fire, the SS/SSO will be notified.

9.0 TRAINING REQUIREMENTS

As a requirement for work at this site, in any mercury work area, field personnel will be required to take the following training. At a minimum, this training must cover the requirements in 29 CFR 1910.1200 Chemical Hazard Communication.

- Visual Inspection: Hazard Communication (abbreviated version)
- Instrument Inspection: Hazard Communication (full version)
- Clean-up: Hazard Communication (full version)/ HASP briefing
- Final Clearance: Hazard Communication (abbreviated training)

All personnel entering a mercury area for clean-up purposes will be trained in the provisions of this site safety plan and be required to sign the Site Safety Plan Acknowledgment in Appendix A.

Site specific training will include the topics shown in the table in Section 9.1. Emergency telephone numbers will be available at each site before any work begins.

9.1 SAFETY BRIEFING

Outlines of safety briefings for IT employees, IT sub-contract personnel, and other personnel are presented below:

SAFETY BRIEFING	
<ul style="list-style-type: none">• HASP sign off• Site background/characterization• Chain of command• Rules and regulations• Personal Protective Equipment/respirator fit test (if applicable)• Emergency Information<ul style="list-style-type: none">– Emergency signal– Gathering point– Responsibilities/roles– Emergency phone numbers• Site Control/Work Zones• Contaminants and Material Safety Data Sheets (MSDS) [Hazard Communication Program]; symptoms of overexposure• Hazards/JSAs• Air Monitoring Program• Incident Reporting• Training Requirements• Medical Surveillance	

9.2 DAILY SAFETY MEETINGS

A safety briefing will be conducted by the crew leader before each shift begins. Topics to be discussed include task hazards and protective measures (physical, chemical, environmental); emergency procedures; PPE levels and other relevant safety topics. Meetings will be documented on the form in Appendix I.

10.0 MEDICAL SURVEILLANCE PROGRAM

Medical exposure monitoring/biological monitoring may be performed if exposure levels are determined to be above the 8 HR TWA/TLV for mercury (0.025 mg/m³), following review of results by the Project CIH and project medical director.

10.1 EXAMINATION SCHEDULE

Medical examinations may be performed for the following purposes:

- At worker request after known or suspected exposure to mercury vapor.
- At the instruction of the CIH, SSO, or employer occupational physician after known or suspected exposure to mercury vapor.
- At the discretion of the employer occupational physician based on prior or present medical conditions.

10.2 OCCUPATIONAL PHYSICIAN

The following information is provided in the event that medical attention is necessary.

- The IT Medical Director is:

Dr. Elayne Theriault
Continuum Health Care
800-229-3674

The IT Medical Director and the Project CIH will be immediately notified of any suspected exposures to hazardous materials/wastes.

APPENDIX A
HEALTH AND SAFETY PLAN CERTIFICATION

N0007789

HEALTH-AND-SAFETY PLAN CERTIFICATION

By signing this document, I am stating that I have read and understand the site health-and-safety plan for IT Corp. personnel, subcontractors, and visitors participating in the NICOR Mercury Restoration Program.

[illegible]

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SUBCONTRACTOR HEALTH & SAFETY PLAN ACKNOWLEDGEMENT

As a duly authorized representative of _____, under
(name of subcontractor)
contract with IT Corporation, I have reviewed and adopt the use of the IT
Corporation Site -Specific Health & Safety Plan* at the NICOR Mercury Restoration
Program.

(name of subcontractor representative/supervisor)

(date)

(signature of subcontractor representative/supervisor)

*Note: The Site Specific Health & Safety Plan (SSHASP) referred to above has been designed for the methods presently contemplated by IT Corporation for the execution of the proposed work. Therefore, this SSHASP may not be appropriate if the work is not performed by or using the methods presently contemplated by IT. Therefore, IT only makes representations or warranties as to the adequacy of the SSHASP for currently anticipated activities and conditions.

N0007791

APPENDIX B
HEALTH AND SAFETY PLAN AMENDMENT
DOCUMENTATION FORM

N0007792

**Site Specific Health & Safety Plan
Amendment Documentation**

Project Name: NICOR Mercury Restoration Program

Project No. _____

Amendment No. _____

Date: _____

Amendment Revises: Page: _____

Section: _____

Task(s) Amendment Affects*: _____

**(Attach new/revised Job Safety Analyses)*

Reason For Amendment:

Amendment:

(Attach separate sheet(s) as necessary)

Completed by: _____

Approved by: _____

N0007793

APPENDIX C
SAFETY OBSERVATION FORM

N0007794

PROPERTY CLEAN-UP

CRITICAL SAFETY PRACTICES

Safety Observation Checklist

<u>Procedure</u>	<u>Property Clean-Up</u>	<u>Safe</u>	<u>At Risk</u>
Clear walkways, work areas of equipment, tools, and debris		<input type="checkbox"/>	<input type="checkbox"/>
Mark, identify, or barricade obstructions		<input type="checkbox"/>	<input type="checkbox"/>
Review hazardous properties of mercury cleaning materials.....		<input type="checkbox"/>	<input type="checkbox"/>
Monitor breathing zone air to determine levels of mercury		<input type="checkbox"/>	<input type="checkbox"/>
Separate Flammables and Oxidizers by 20 feet minimum		<input type="checkbox"/>	<input type="checkbox"/>
Store flammable liquids in well ventilated areas, away from work areas		<input type="checkbox"/>	<input type="checkbox"/>
Identify any confined/restricted spaces where permits may be necessary		<input type="checkbox"/>	<input type="checkbox"/>
Review emergency procedures before work commences		<input type="checkbox"/>	<input type="checkbox"/>
Wear proper level of PPE for mercury exposure		<input type="checkbox"/>	<input type="checkbox"/>
Assess noise level with sound level meter if possibility exists that level may exceed 85 dB A TWA.....		<input type="checkbox"/>	<input type="checkbox"/>
Eliminate any sources of ignition from the work area		<input type="checkbox"/>	<input type="checkbox"/>
Prohibit Smoking in work areas.....		<input type="checkbox"/>	<input type="checkbox"/>
Prohibit storage, transfer of flammable liquids in plastic containers.....		<input type="checkbox"/>	<input type="checkbox"/>
Enforce use of approved flammable liquid safety cans.....		<input type="checkbox"/>	<input type="checkbox"/>
De-energize or shut off utility lines at their source before working on utilities		<input type="checkbox"/>	<input type="checkbox"/>
Use double insulated or properly grounded electric power-operated tools		<input type="checkbox"/>	<input type="checkbox"/>
Provide an equipment-grounding conductor program or employ ground-fault circuit interrupters		<input type="checkbox"/>	<input type="checkbox"/>
Use qualified electricians to hook up electrical circuits.....		<input type="checkbox"/>	<input type="checkbox"/>
Inspect all extension cords daily for structural integrity, ground continuity, and damaged insulation		<input type="checkbox"/>	<input type="checkbox"/>
Cover or elevate electric wire or flexible cord passing through work areas to protect from damage.....		<input type="checkbox"/>	<input type="checkbox"/>
Inspect all electrical power circuits prior to commencing work.....		<input type="checkbox"/>	<input type="checkbox"/>
Keep all lines, plugs and receptacles out of water		<input type="checkbox"/>	<input type="checkbox"/>
Lockout/tag-out/de-electrical energize equipment before maintenance according to Procedure HS315.....		<input type="checkbox"/>	<input type="checkbox"/>
Identify staging area for debris		<input type="checkbox"/>	<input type="checkbox"/>
Follow all manufacturers instructions for operation of power tools		<input type="checkbox"/>	<input type="checkbox"/>

<u>Body Use</u>	<u>Property Clean-Up</u>	<u>Safe</u>	<u>At Risk</u>
Use 3 point contact when ascending/descending ladders/elevated platforms....		<input type="checkbox"/>	<input type="checkbox"/>
Observe proper lifting techniques		<input type="checkbox"/>	<input type="checkbox"/>
Obey sensible lifting limits (60 lb. maximum per person manual lifting)		<input type="checkbox"/>	<input type="checkbox"/>

<u>Personal Protective Equipment</u>	<u>Property Clean-Up</u>	<u>Safe</u>	<u>At Risk</u>
Wear reflective warning vests worn when exposed to vehicular traffic		<input type="checkbox"/>	<input type="checkbox"/>
Use mechanical lifting equipment (hand carts, trucks) to move large, awkward loads		<input type="checkbox"/>	<input type="checkbox"/>
Wear cut resistant work gloves when the possibility of lacerations or other injury may be caused by sharp edges or objects		<input type="checkbox"/>	<input type="checkbox"/>
Wear proper skin, eye and respiratory protection based on the exposure levels of mercury		<input type="checkbox"/>	<input type="checkbox"/>
Wear hard hats, safety glasses with side shields, and steel-toe safety boots for heavy repair work.....		<input type="checkbox"/>	<input type="checkbox"/>
Use hearing protection when exposed to excessive noise levels (greater than 85 dBA over an 8-hour work period)		<input type="checkbox"/>	<input type="checkbox"/>
Provide ABC (or equivalent) fire extinguishers for all flammable storage areas, powered cutting equipment re-fueling areas, fuel powered generators and compressors		<input type="checkbox"/>	<input type="checkbox"/>

<u>Equipment/Tools/Vehicles</u>	<u>Property Clean-up</u>	<u>Safe</u>	<u>At Risk</u>
Maintain all hand and power tools in a safe condition		<input type="checkbox"/>	<input type="checkbox"/>
Keep guards in place during use		<input type="checkbox"/>	<input type="checkbox"/>
Use approved water-proof, weather-proof type electrical components if exposure to moisture is likely		<input type="checkbox"/>	<input type="checkbox"/>
Shut-off / idle power tools walking between work areas.....		<input type="checkbox"/>	<input type="checkbox"/>
Shut off equipment during re-fueling.....		<input type="checkbox"/>	<input type="checkbox"/>
Provide ABC (or equivalent) fire extinguishers for all hot work		<input type="checkbox"/>	<input type="checkbox"/>
Prohibit use of defective tools/equipment		<input type="checkbox"/>	<input type="checkbox"/>

APPENDIX D
HAZARD COMMUNICATION PROGRAM

N0007797

1.0 OBJECTIVE

A Site Specific Hazard Communication (Employee Right-To-Know) Program will be instituted for the NICOR Mercury Restoration Program.

2.0 PURPOSE

The purpose of Hazard Communication (Employee Right-to-Know) is to ensure that the hazards of all operational chemicals used in the execution of restoration activities are transmitted (communicated), according to 29 CFR 1910.1200 and 29 CFR 1926.59 to all IT personnel and IT subcontractors.

3.0 GENERAL REQUIREMENTS

- 3.1 It is the responsibility of the Site Supervisor to ensure that the Hazard Communication Program for the area under their supervision is updated as necessary.
- 3.2 Container Labeling — The Site Supervisor shall verify that all drums and containers are labeled according to contents. These drums and containers will include those from manufacturers and those produced by on site operations (waste). All incoming and outgoing labels shall be checked for chemical/waste identity, hazard warning, and name and address of responsible party.
- 3.3 Material Safety Data Sheets (MSDSs) — There will be an MSDS located on site for each hazardous operational chemical that is being used on site. All MSDSs will be located in the site health and safety plan that can be found in the crew vehicle.
- 3.4 Employee Information and Site Specific Training — Training employees on chemical hazards is accomplished through ongoing corporate training programs. Additionally, chemical hazards will be communicated to employees through daily safety meetings held by project crews and by initial orientation programs.
- 3.5 Employees are instructed on the following:
 - Chemicals and their hazards
 - How to prevent exposure to these hazardous chemicals
 - What the company has done to prevent workers' exposure to these chemicals
 - Procedures to follow if they are exposed to these chemicals
 - How to read and interpret labels and MSDSs for hazardous substances
 - Emergency spill procedures
 - Proper storage and labeling
- 3.6 Before any new hazardous chemical is introduced for use, each employee will be given information in the same manner as during the initial safety class. The Site Supervisor will be responsible for verifying that the MSDS on the new chemical is available. During the daily safety meetings, information on each new chemical will be presented.
- 3.7 Upon reading the Hazard Communication Program employees will be asked to sign the "Worker Hazard Communication Acknowledgment Form". The Hazard Communication Program will also be reviewed with new employees. These persons will also be asked to sign the acknowledgment form. The Hazard Communication Program shall be available for review by anyone on site at any time during normal work hours.
- 3.8 The Project CIH shall update the Hazard Communication Program as necessary.

4.0 RESPONSIBILITIES

Overall responsibility for compliance with the site specific Hazard Communication Program rests with the Site Supervisor. A brief outline of responsibilities for those persons directly involved with the program will follow. These responsibilities are not all inclusive, but are designed to give guidance in initial and long-term program development. Since each area is different, these responsibilities may vary.

N0007798

This program is intended to cover those employees who are directly involved with the handling of hazardous operational chemicals or supervision of activities that involve the use of hazardous chemicals.

4.1 PROJECT CIH RESPONSIBILITIES

- Advise supervisory people as to which materials may need to be considered hazardous initially and eventually to ensure that hazard task determination is being done according to the written policy.
- Follow up through safety meetings and safety audits to verify that supervisors are complying with the program.
- Notify supervisors immediately of any operating changes affecting the hazardous chemicals being used.

4.2 SITE SUPERVISORS' RESPONSIBILITIES

- Identify tasks requiring the use of hazardous chemicals and develop a list of those tasks and chemicals.
- Provide the training required by the Hazard Communication Standard and document training of employees in the safe handling of hazardous chemicals.
- Ensure inspection of engineering controls and personal protective equipment before each use.
- Make daily surveys of the work area to verify that safe practices are being followed. Advise employees of and document unsafe work practices on the first occasion and consider further unsafe work practices as disciplinary violations. Use documentation as topics of safety meetings.
- Verify required labeling practices are being followed. Labels should be affixed to the container when it arrives. If the contents are transferred to another container, then all label information (manufacturer, manufacturer's telephone number, product name, target organ(s) and product number) must also be affixed to the new container, so that all containers of the material, regardless of size, are labeled. Contact the Project CIH for proper labels.
- Enforce all applicable safety and health standards through periodic documented audits.

4.3 EMPLOYEE RESPONSIBILITIES

- Read and understand entire Site Specific Hazard Communication Program.
- Obey established safety rules and regulations.
- Use all safety procedures and personal protective equipment as required by established procedures.
- Notify supervisor of the following:
 - Any symptoms or unusual effects that may be related to the use of hazardous chemicals.
 - Any missing, incomplete, or unreadable labels on containers.
 - Missing, damaged, or malfunctioning safety equipment.
- Use approved labels on containers; do not remove labels.
- Use only approved containers for hazardous chemicals. (Is chemical and container compatible and appropriate?)
- Know where emergency equipment and first-aid supplies are located.
- Know location of MSDSs. These will be located in the crew vehicle.
- Know what you are expected to do in case of an emergency. Before the commencement of any task, emergency considerations shall be made.

5.0 HAZARD DETERMINATION

IT will rely on MSDSs from chemical suppliers and manufacturers will be relied upon to meet hazard determination requirements. Other relevant data from laboratory analyses, chemical reference materials, and chemical manufacturers' written evaluation procedures will be utilized when warranted. No other method shall be used to determine a chemicals' hazards unless approved by the Project CIH.

6.0 LABELING

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The Site Supervisor will be responsible for seeing that all containers are properly and clearly labeled. The Site Supervisor shall also check all labels for chemical identity and appropriate hazard warnings. If the hazardous chemical is regulated by OSHA in a substance specific health standard (29 CFR 1910), the Site Supervisor shall ensure that the labels or other forms of warning used are in accordance with the requirements of that standard. Any container that is not labeled shall be immediately labeled after initial discovery with the required information.

The Site Supervisor shall be responsible for seeing that all portable containers used are properly labeled with chemical identity and hazard warning. (Refer to MSDS for required labeling information.)

The Site Supervisor shall also ensure that labels on hazardous chemical containers are not removed or defaced unless the container is immediately marked with the required information and that all labels are legible and prominently displayed on the container.

If any container is found and the contents cannot be identified, the Site Supervisor shall be contacted immediately. When proper identification is made, a label shall be affixed to the container immediately. If it is discovered that no MSDS is available, the Project CIH shall be contacted to assist in locating the proper MSDS. If there is no means of identifying the material in the container, the container shall be taken out of service, away from all personnel, until it can be tested for identification. The Site Supervisor shall communicate their findings or awareness of such containers to all personnel working in the area and to the Project CIH.

7.0 MATERIAL SAFETY DATA SHEETS (MSDS)

Site Supervisors will be responsible for maintaining a current MSDS relevant to the hazardous chemicals used by their crews. The Project CIH is responsible for compiling the initial MSDS file for the project.

All MSDSs shall be readily available for review by all employees during each work shift. MSDSs shall also be made available, upon request, to designated IT representatives, other employer's employees, and to any OSHA inspector in accordance with the requirements of 29 CFR 1910.1200(e).

Site Supervisors that are without proper MSDSs shall be responsible for requesting this information from the Project CIH.

8.0 EMPLOYEE INFORMATION AND TRAINING

It is the responsibility of the supervisor in charge of each employee to ensure that the employee is properly trained. Training employees on chemical hazards and chemical handling is accomplished at the time of initial employment, whenever a new chemical (or physical) hazard is introduced into the work area, and through ongoing formal and informal training programs. Additionally, chemical hazards are communicated to employees through weekly and morning safety meetings, which shall be documented according to topic, major points discussed, and names of those attending. Records of all formal training conducted at IT are coordinated and maintained by the Training Department secretary.

At a minimum, employees shall be informed on the following:

- The requirements of 29 CFR 1910.1200--Hazard Communication--Evaluating the potential hazards of chemicals and communicating information concerning hazards and appropriate protective measures to employees. Employee training can be accomplished in several different ways including, but not limited, to 40-hour OSHA Hazardous Waste Worker Training (29 CFR 1910.120), periodic safety meetings, job-site safety meetings, and formal and informal training about specific chemical hazards.
- The location and availability of the written Hazard Communication Program, list of hazardous chemicals, and MSDSs.
- Any operations where hazardous chemicals are used.
- How to work safely with chemicals present in the workplace and minimize potential exposure.

Employee training shall include the following:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (monitoring instruments, visual appearance or odor, and acute and chronic health effects).
- The physical, chemical, and health hazards of the chemicals being used.
- The methods of preventing exposure to hazardous chemicals.
- Procedures to follow employees if are exposed to hazardous chemicals. These discussions shall include proper operating procedures for all emergency equipment.
- The details of the written Hazard Communication Program, including an explanation of the labeling system and the MSDSs, and how employees can obtain and use the appropriate hazard information.
- Procedures for workers involved in non-routine tasks.

Each Site Supervisor shall ensure that the above training is emphasized.

9.0 HAZARDOUS NON-ROUTINE TASKS

Occasionally, employees are required to perform tasks which are considered to be non-routine. All tasks considered to be non-routine shall be carefully discussed among the supervisor and those performing the task. This safety briefing shall include the possible hazards an employee may encounter while participating in the Mercury Restoration Program, including:

- Hazard recognition
- Chemicals involved and their hazardous properties
- Physical hazards
- Methods of avoiding hazards (monitoring instruments, proper personal protective equipment, etc.)

The following is a list of some of the non-routine tasks which may occur:

Confined Space Entry

- Confined Space Entry
- Decontamination of Equipment
- High-Pressure Washer Operation
- Hot Work

10.0 INFORMING CONTRACTORS

It shall be the responsibility of the Site Supervisor to provide subcontractors with the following information:

- Hazardous chemicals to which they may be exposed while performing a task including the following:
 - Chemical properties
 - Physical properties
 - Acute/Chronic health effects.
- Location:
 - MSDS for work area
 - Hazard Communication Program
 - Other relevant safety material.
- Precautionary measures to be taken to protect employees from chemical and physical hazards.
- Location of nearest emergency equipment (fire extinguisher, phone, first-aid kit, etc.).
- Procedures to follow in the event of employee exposure.

- Steps that have been taken to reduce the risk of exposure to physical and chemical hazards including the following:
 - Safety meetings
 - Hazard Communication Program
 - Proper storage and labeling of hazardous chemicals
 - Safety inspections.
- The methods used to label all hazardous chemicals.

The Project CIH shall offer assistance in providing the above information to subcontractors. On acceptance of the contract by a subcontractor, a "Contractor Right-to-Know" release form shall be completed. This form will state that the above information has been communicated to the perspective contractor.

10.1 CONTRACTOR RIGHT-TO-KNOW ACKNOWLEDGEMENT

By signing this sheet, the signee is stating that an IT employee or representative has briefed said signee on the essentials of IT's Hazard Communication Program, including hazardous chemical(s) to which one may be exposed, location of program and MSDS, precautionary measures taken to protect contractors from chemical and physical hazards, location of emergency equipment, procedures to follow in the event of employer's employee chemical exposure, and method used to label all hazardous chemicals.

Name	Date	Company

11.0 LIST OF HAZARDOUS CHEMICALS

The following is a list of hazardous chemicals that may be used to complete the Mercury Restoration Program. Further information on each hazardous chemical listed below can be found in the MSDS, which are included in this site-specific health and safety plan.

- Operational Chemicals:
 - Activated Charcoal, Powder
 - Anti-fog Bausch & Lomb
 - Diesel Fuel
 - Hydrochloric Acid
 - Hg-X
 - Mercury
 - Mercury Indicator
 - Mercury Spill Cleanup Kit
 - Mercury Sponge

N0007802

- Mersorb
- Nitric Acid
- Regular Unleaded Gasoline
- Resisorb ® - Mercury Vapor Absorbent
- Sulfur

N0007803

APPENDIX E
MATERIALS SAFETY DATA SHEETS

N0007804

BAUSCH & LOMB -- SIGHT SAVERS BRAND ANTI-FOG LIQUID
MATERIAL SAFETY DATA SHEET
NSN: 793000N016747
Manufacturer's CAGE: 64804
Part No. Indicator: A
Part Number/Trade Name: SIGHT SAVERS BRAND ANTI-FOG LIQUID

=====

General Information

=====

Company's Name: BAUSCH & LOMB
Company's Street: 1400 N GOODMAN ST
Company's City: ROCHESTER
Company's State: NY
Company's Country: US
Company's Zip Code: 14609
Company's Emerg Ph #: 800-553-5340
Company's Info Ph #: 800-553-5340
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 07FEB90
Safety Data Review Date: 03MAR93
MSDS Serial Number: BRRYH
Hazard Characteristic Code: NK

=====

Ingredients/Identity Information

=====

Proprietary: NO
Ingredient: ISOPROPYL ALCOHOL (SARA III)
Ingredient Sequence Number: 01
Percent: 12
NIOSH (RTECS) Number: NT8050000
CAS Number: 67-63-0
OSHA PEL: 400 PPM;500 STEL
ACGIH TLV: 400 PPM;500 STEL

Proprietary: NO
Ingredient: DODECYL SULFATE, SODIUM SALT
Ingredient Sequence Number: 02
Percent: 2
NIOSH (RTECS) Number: WT1050000
CAS Number: 151-21-3
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO
Ingredient: DIPROPYLENE GLYCOL METHYL ETHER
Ingredient Sequence Number: 03
Percent: 2
NIOSH (RTECS) Number: JM1575000

CAS Number: 34590-94-8
OSHA PEL: 100 PPM;150 STEL,S
ACGIH TLV: 100 PPM;150 STEL,S

Physical/Chemical Characteristics

Appearance And Odor: PURPLE LIQUID, ODOR OF RUBBING ALCOHOL
Boiling Point: 212F,100C
Melting Point: N/A
Vapor Pressure (MM Hg/70 F): 30
Specific Gravity: 1
Evaporation Rate And Ref: <1
Solubility In Water: SOLUBLE

Fire and Explosion Hazard Data

Flash Point: 105F,41C
Flash Point Method: OC
Extinguishing Media: CO*2, FOAM, DRY CHEMICAL, WATER FOG.
Special Fire Fighting Proc: WEAR NIOSH/MSHA APPROVED SCBA & FULL
PROTECTIVE EQUIPMENT (FP N).
Unusual Fire And Expl Hazrds: NONE.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): SOURCES OF IGNITION, HEAT, OPEN FLAME.
Materials To Avoid: HYDROGEN/PALLADIUM, NITROFORM, OLEUM, POTASSIUM-TERT-
BUTOXIDE, ALUMINUM, ALUMINUM ISOPROPOXIDE, CROTONALDEHYDE, (SUPDAT)
Hazardous Decomp Products: CARBON MONOXIDE, CARBON DIOXIDE, SILICON OXIDE.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT.

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: NO
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHAL:IRRITATION, CENTRAL NERVOUS SYSTEM
DEPRESSION. SKIN:DEFATTING, DERMATITIS POSSIBLE. INGEST:NAUSEA, VOMITING,
HEADACHE, DIZZINESS, COMA POSSIBLE, ABDOMINAL PAIN, VOMITING, DIARRHEA.
EYE:IRRITATION.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT RELEVANT.
Signs/Symptoms Of Overexp: SEE HEALTH HAZARDS.
Med Cond Aggravated By Exp: NOT APPLICABLE.
Emergency/First Aid Proc: INHAL:MOVE TO FRESH AIR, GET MD. SKIN:WASH WITH
SOAP & WATER. INGEST:GASTRIC LAVAGE, GIVE FLUIDS, GET MD. EYE:FLUSH WITH

N0007806

WATE. OR AT LEAST 15 MINUTES, GET MD.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: REMOVE SOURCES OF IGNITION, ABSORB WITH
VERMICULITE.

Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.

Waste Disposal Method: DISPOSAL MUST BE IN ACCORDANCE WITH LOCAL, STATE
AND FEDERAL REGULATIONS.

Precautions-Handling/Storing: STORE IN A COOL, DRY, WELL VENTILATED PLACE.

Other Precautions: NONE SPECIFIED BY MANUFACTURER.

Control Measures

Respiratory Protection: NIOSH/MSHA APPROVED RESPIRATOR IF EXPOSURE EXCEEDS
PEL.

Ventilation: SUFFICIENT TO KEEP EXPOSURE BELOW PEL, GENERAL ROOM AIR
CIRCULATION SUFFICIENT FOR NORMAL USE OF PRODUCT.

Protective Gloves: IMPERVIOUS GLOVES (FP N).

Eye Protection: CHEMICAL WORKERS GOGGLES (FP N).

Other Protective Equipment: NONE REQUIRED FOR NORMAL USE OF PRODUCT.

Work Hygienic Practices: NOT APPLICABLE.

Suppl. Safety & Health Data: MATLS TO AVOID:OXIDANTS, PHOSGENE.

Transportation Data

Disposal Data

Label Data

Label Required: YES

Technical Review Date: 10MAR93

Label Date: 10MAR93

Label Status: G

Common Name: SIGHT SAVERS BRAND ANTI-FOG LIQUID

Chronic Hazard: NO

Signal Word: WARNING!

Acute Health Hazard-Slight: X

Contact Hazard-Slight: X

Fire Hazard-Moderate: X

Reactivity Hazard-None: X

Special Hazard Precautions: COMBUSTIBLE. KEEP AWAY FROM HEAT AND OPEN
FLAME. ACUTE:SWALLOWING CAN CAUSE NAUSEA, VOMITING, HEADACHE, DIZZINESS,
COMA POSSIBLE, ABDOMINAL PAIN, VOMITING, DIARRHEA. INHALATION CAN CAUSE
IRRITATION. CAN CAUSE EYE AND SKIN IRRITATION. CHRONIC:NONE LISTED BY
MANUFACTURER.

Protect Eye: Y

Protect Skin: Y

Protect Respiratory: Y

Lab Name: BAUSCH & LOMB
Label Street: 400 N GOODMAN ST
Label City: ROCHESTER
Label State: NY
Label Zip Code: 14609
Label Country: US
Label Emergency Number: 800-553-5340

N0007808

Please reduce your browser font size for better viewing and printing.

MSDS**Material Safety Data Sheet**

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865



24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-898-6886

Outside U.S. and Canada
Chemtrec: 202-483-7819

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

CARBON, ACTIVATED, POWDER

MSDS Number: C0935 --- Effective Date: 08/25/00

1. Product Identification

Synonyms: Charcoal, Activated
CAS No.: 7440-44-0
Molecular Weight: 12.01
Chemical Formula: C
Product Codes: 3370, 5010, E343

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Activated Carbon	7440-44-0	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! ACTIVATED CARBON AFFECTS THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight

Flammability Rating: 1 - Slight

Reactivity Rating: 1 - Slight

Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES

Storage Color Code: Orange (General Storage)

Potential Health Effects**Inhalation:**

No adverse effects expected. May cause mild irritation to the respiratory tract.

Ingestion:

No adverse effects expected. May cause mild irritation to the gastrointestinal tract.

Skin Contact:

Not expected to be a health hazard from skin exposure. May cause mild irritation and redness.

Eye Contact:

No adverse effects expected. May cause mild irritation, possible reddening.

Chronic Exposure:

Prolonged inhalation of excessive dust may produce pulmonary disorders.

Aggravation of Pre-existing Conditions:

No information found.

4. First Aid Measures

Inhalation:

Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:

Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.

Skin Contact:

Not expected to require first aid measures. Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Contact:

Wash thoroughly with running water. Get medical advice if irritation develops.

5. Fire Fighting Measures

Fire:

As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source. Activated carbon is difficult to ignite and tends to burn slowly (smolder) without producing smoke or flame. Wet activated carbon depletes oxygen from the air. Materials allowed to smolder for long periods in enclosed spaces, may produce amounts of carbon monoxide which may reach the lower explosive limit for carbon monoxide of 12.5% in air. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Minimum explosible concentration 0.140 g/l.

Fire Extinguishing Media:

Water spray, dry chemical, alcohol foam, or carbon dioxide.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. Warning! Spent product may have absorbed hazardous materials.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Keep away from moisture and oxidizers. Avoid dust dispersal. Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered in confined spaces. Work procedures for potentially low oxygen areas should be followed. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

- OSHA Permissible Exposure Limits (PELs):

activated carbon (graphite, synthetic): total particulate = 15 mg/m³ (TWA), respirable fraction = 5 mg/m³ (TWA).

- ACGIH Threshold Limit Values (TLVs):

graphite, all forms except graphite fibers: 2 mg/m³ (TWA).

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator.

WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Black powder.

Odor:

Odorless.

Solubility:

Insoluble in water.

Specific Gravity:

1.8 - 2.1

pH:

5.0-10.0

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

Sublimes.

Melting Point:

3550C (6422F)

Vapor Density (Air=1):

0.4

Vapor Pressure (mm Hg):

1 @ 3586C (6487F)

N0007812

vaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Involvement in a fire causes formation of carbon dioxide and carbon monoxide.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in rapid combustion. Avoid contact with strong acids.

Conditions to Avoid:

Moisture and incompatibles.

11. Toxicological Information

Investigated as a reproductive effector.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Activated Carbon. (7440-44-0)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

International (Water, I.M.O.)

Proper Shipping Name: CARBON, ACTIVATED
Hazard Class: 4.2
UN/NA: UN1362
Packing Group: III
Information reported for product/size: 50LB

International (Air, I.C.A.O.)

Proper Shipping Name: CARBON, ACTIVATED
Hazard Class: 4.2
UN/NA: UN1362
Packing Group: III
Information reported for product/size: 50LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Activated Carbon (7440-44-0) Yes Yes No Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea DSL NDSL Phil.

Activated Carbon (7440-44-0) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
-SARA 302- -SARA 313-----
Ingredient RQ TPQ List Chemical Catg.

Activated Carbon (7440-44-0) No No No No

-----\Federal, State & International Regulations - Part 2\-----			
Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8 (d)
Activated Carbon (7440-44-0)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: No information found.

Poison Schedule: No information found.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 0 Flammability: 1 Reactivity: 0

Label Hazard Warning:

CAUTION! ACTIVATED CARBON AFFECTS THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS.

Label Precautions:

Avoid contact with eyes, skin and clothing.

Avoid breathing dust.

Keep container closed.

Use with adequate ventilation.

Wash thoroughly after handling.

Label First Aid:

If inhaled, remove to fresh air. Get medical attention for any breathing difficulty.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 1, 3, 5, 7, 9, 10, 15, 16.

Disclaimer:

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

AMOCO OIL -- AMOFUEL NO. 2 DIESEL - DIESEL FUEL
MATERIAL SAFETY DATA SHEET
NSN: 9140010625531
Manufacturer's CAGE: 15958
Part No. Indicator: A
Part Number/Trade Name: AMOFUEL NO. 2 DIESEL

=====

General Information

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Item Name: DIESEL FUEL
Company's Name: AMOCO OIL CO
Company's Street: 200 E RANDOLPH DR MC 1408
Company's City: CHICAGO
Company's State: IL
Company's Country: US
Company's Zip Code: 60601-6401
Company's Emerg Ph #: 800-447-8735/800-424-9300 CHEMTREC
Company's Info Ph #: 312-856-3907
Record No. For Safety Entry: 002
Tot Safety Entries This Stk#: 003
Status: SE
Date MSDS Prepared: 25JUL89
Safety Data Review Date: 07MAR91
Supply Item Manager: KY
MSDS Preparer's Name: R. G. FARMER
MSDS Serial Number: BJPTX
Hazard Characteristic Code: F4
Unit Of Issue: NK

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Ingredients/Identity Information

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Proprietary: NO
Ingredient: ALIPHATIC PETROLEUM DISTILLATES
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: 1003049AP
CAS Number: 68476-30-2
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE SPECIFIED

Proprietary: NO
Ingredient: NAPHTHALENE (SARA III)
Ingredient Sequence Number: 02
Percent: 1
NIOSH (RTECS) Number: QJ0525000
CAS Number: 91-20-3
OSHA PEL: 10 PPM/15 STEL
ACGIH TLV: 10 PPM/15 STEL; 9192
Other Recommended Limit: NONE SPECIFIED

Proctetary: NO
Ingredient: XYLENES (O-,M-,P- ISOMERS) (SARA III)
Ingredient Sequence Number: 03
Percent: 1
NIOSH (RTECS) Number: ZE2100000
CAS Number: 1330-20-7
OSHA PEL: 100 PPM/150 STEL
ACGIH TLV: 100 PPM/150STEL;9192
Other Recommended Limit: NONE SPECIFIED

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Physical/Chemical Characteristics

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Appearance And Odor: CLEAR, BRIGHT LIQUID
Boiling Point: 340F,171C
Specific Gravity: 0.88
Decomposition Temperature: UNKNOWN
Solubility In Water: NEGLIGIBLE
Viscosity: 1.8 CS @100F
Corrosion Rate (IPY): UNKNOWN

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Fire and Explosion Hazard Data

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Flash Point: 120F,49C
Flash Point Method: TCC
Lower Explosive Limit: 0.6
Upper Explosive Limit: 7.5
Extinguishing Media: USE WATER FOG, CARBON DIOXIDE, FOAM, OR DRY CHEMICAL.
(EXTINGUISHING AGENTS APPROVED FOR CLASS B HAZARDS)
Special Fire Fighting Proc: FIRE FIGHTERS SHOULD USE NIOSH APPROVED SCBA &
FULL PROTECTIVE EQUIPMENT WHEN FIGHTING CHEMICAL FIRE. USE WATER SPRAY TO
COOL NEARBY CONTAINERS EXPOSED TO FIRE.
Unusual Fire And Expl Hazrds: FIRE OR EXCESSIVE HEAT MAY CAUSE PRODUCTION
OF HAZARDOUS DECOMPOSITION PRODUCTS.

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Reactivity Data

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Stability: YES
Cond To Avoid (Stability): HIGH TEMPERATURES, SPARKS, AND OPEN FLAMES
Materials To Avoid: STRONG OXIDIZING AGENTS
Hazardous Decomp Products: BY FIRE: CARBON MONOXIDE, CARBON DIOXIDE
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT APPLICABLE

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Health Hazard Data

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LD50-LC50 Mixture: LD50 (ORAL RAT) IS EXPECTED > 5G/KG
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: EYE:IRRITATION. SKIN:MILDLY IRRITATING.
RESPIRATORY SYSTEM IRRITATION AND LIGHT HEADEDNESS. MAY CAUSE NAUSEA,

HEA. IE, DROWSINESS, VOMITING. INGESTION: SOLVENT ASPIRATION INTO LUNGS AS A RESULT OF VOMITING MAY CAUSE LUNG AND DIGESTIVE SYSTEM DAMAGE.

Carcinogenicity - NTP: NO

Carcinogenicity - IARC: NO

Carcinogenicity - OSHA: NO

Explanation Carcinogenicity: NONE OF THE COMPOUNDS IN THIS PRODUCT IS LISTED BY IARC, NTP, OR OSHA AS A CARCINOGEN. (DIESEL EXHAUST IS POTENTIAL)

Signs/Symptoms Of Overexp: VAPORS IN HIGH CONCENTRATION ARE ANESTHETIC.

OVEREXPOSURE MAY RESULT IN FATIGUE, WEAKNESS, CONFUSION EUPHORIA, DIZZINESS, HEADACHE, DILATED PUPILS, LACRIMATION, NERVOUSNESS, MUSCLE FATIGUE, INSOMNIA, PARESTHESIA, DERMATITIS, AND PHOTOPHOBIA. CAN CAUSE TEARING, REDNESS OF EYES AND BLURRED VISION. IRRITATION OF SKIN.

Med Cond Aggravated By Exp: PERSONS WITH A HISTORY OF AILMENTS OR WITH A PRE-EXISTING DISEASE INVOLVING THE EYES, SKIN, RESPIRATORY TRACT OR NERVOUS SYSTEM MAY BE AT INCREASED RISK FROM EXPOSURE. DRYING/CRACKING OF SKIN.

Emergency/First Aid Proc: EYES: FLUSH WITH RUNNING WATER FOR 15 MINUTES WHILE HOLDING EYELID. GET MEDICAL ATTENTION IMMEDIATELY. SKIN: WASH WITH REMOVE TO FRESH AIR. GIVE MOUTH-TO-MOUTH RESUSCITATION IF NOT BREATHING. GET MEDICAL ATTENTION. INGESTION: DO NOT INDUCE VOMITING. GIVE NOTHING BY MOUTH IF UNCONSCIOUS. GET MEDICAL ATTENTION IMMEDIATELY.

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Precautions for Safe Handling and Use

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Steps If Matl Released/Spill: REMOVE ALL SOURCES OF IGNITION. VENTILATE AND REMOVE WITH INERT ABSORBENT. USE NON-SPARKING TOOLS.

Neutralizing Agent: NOT APPLICABLE

Waste Disposal Method: WASTE MATERIAL MAY BE A HAZARDOUS WASTE (CODE D001) WHICH MUST BE DISPOSED OF ACCORDINGLY. DO NOT INCINERATE CLOSED CONTAINER. DISPOSE OF IN ACCORDANCE WITH FEDERAL, STATE AND LOCAL REGULATIONS.

Precautions-Handling/Storing: CONTENTS ARE FLAMMABLE. KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME. DURING USE AND UNTIL ALL VAPORS ARE GONE: KEEP AREA VENTILATED-DO NOT SMOKE.

Other Precautions: AVOID BREATHING OF VAPORS. LABORATORY TESTS ON ANIMALS HAVE SHOWN THAT EXPOSURE CAN CAUSE SKIN TUMORS. ALWAYS PROMPTLY WASH OFF ANY EXPOSED SKIN.

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Control Measures

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Respiratory Protection: WEAR A NIOSH/MSHA APPROVED RESPIRATOR IF VENTILATION DOES NOT MAINTAIN INHALATION EXPOSURES BELOW PEL/TLV. WEAR SELF-CONTAINED BREATHING APPARATUS IF REQUIRED FOR HIGH LEVELS OF CONTAMINATES.

Ventilation: LOCAL EXHAUST PREFERABLE. GENERAL EXHAUST ACCEPTABLE IF THE EXPOSURE IS MAINTAINED BELOW APPLICABLE EXPOSURE LIMITS.

Protective Gloves: NEOPRENE OR NATURAL RUBBER GLOVES

Eye Protection: PAINT GOGGLES/SAFETY GLASSES AS REQUIRED

Other Protective Equipment: INDUSTRIAL-TYPE WORK CLOTHING, HAT AND APRON AS REQUIRED. AN EYE WASH AND DRENCH SHOWER FACILITY SHOULD BE AVAILABLE.

Work Hygienic Practices: USE WITH ADEQUATE VENTILATION. AVOID BREATHING VAPOR/SPRAY MIST. AVOID CONTACT WITH SKIN/EYES. WASH HANDS/SKIN AFTER USE

Suppl. Safety & Health Data: KEEP CONTAINER CLOSED WHEN NOT IN USE.

TRAN R ONLY TO APPROVED CONTAINERS WITH COMPLETE AND APPROPRIATE LABELING. DO NOT TAKE INTERNALLY. KEY1:THIS NSN HAS BEEN CANCELLED.

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Transportation Data

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Trans Data Review Date: 91066
DOT PSN Code: LKZ
DOT Proper Shipping Name: PETROLEUM DISTILLATES, N.O.S. OR PETROLEUM PRODUCTS, N.O.S.
DOT Class: 3
DOT ID Number: UN1268
DOT Pack Group: III
DOT Label: FLAMMABLE LIQUID
IMO PSN Code: LMH
IMO Proper Shipping Name: PETROLEUM DISTILLATES, N.O.S. o
IMO Regulations Page Number: 3375
IMO UN Number: 1268
IMO UN Class: 3.3
IMO Subsidiary Risk Label: -
IATA PSN Code: TJB
IATA UN ID Number: 1268
IATA Proper Shipping Name: PETROLEUM DISTILLATES, N.O.S.
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
AFI PSN Code: TJB
AFI Prop. Shipping Name: PETROLEUM DISTILLATES, N.O.S.
AFI Class: 3
AFI ID Number: UN1268
AFI Pack Group: III
AFI Basic Pac Ref: 7-7
Additional Trans Data: MSDS GIVES FLASH POINT RANGE 120F-180F, BOILING POINT RANGE 340F-675F.

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Disposal Data

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Label Data

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Label Required: YES
Technical Review Date: 07MAR91
Label Status: F
Common Name: AMOFUEL NO. 2 DIESEL
Chronic Hazard: NO
Signal Word: WARNING!
Acute Health Hazard-Slight: X
Contact Hazard-Slight: X
Fire Hazard-Moderate: X
Reactivity Hazard-None: X
Special Hazard Precautions: EYE:IRRITATION. SKIN:MILDLY IRRITATING. RESPIRATORY SYSTEM IRRITATION AND LIGHT HEADEDNESS. MAY CAUSE NAUSEA, HEADACHE, DROWSINESS, VOMITING. INGESTION:SOLVENT ASPIRATION INTO LUNGS AS

A RISK OF VOMITING MAY CAUSE LUNG AND DIGESTIVE SYST DAMAGE REMOVE ALL SOURCES OF IGNITION. VENTILATE AND REMOVE WITH INERT ABSORBENT. USE NON-SPARKING TOOLS. CONTENTS ARE FLAMMABLE. KEEP AWAY FROM HEAT, SPARKS, AND OPEN FLAME. DURING USE AND UNTIL ALL VAPORS ARE GONE: KEEP AREA VENTILATED-DO NOT SMOKE.

Protect Eye: Y

Protect Skin: Y

Protect Respiratory: Y

Label Name: AMOCO OIL CO

Label Street: 200 E RANDOLPH DR MC 1408

Label City: CHICAGO

Label State: IL

Label Zip Code: 60601-6401

Label Country: US

Label Emergency Number: 800-447-8735/800-424-9300 CHEMTREC

BP OIL -- GASOLINE, BP REGULAR UNLEADED
MATERIAL SAFETY DATA SHEET
NSN: 913000N082378
Manufacturer's CAGE: 82250
Part No. Indicator: A
Part Number/Trade Name: GASOLINE, BP REGULAR UNLEADED

=====
General Information
=====

Company's Name: BP OIL CO
Company's Street: 200 PUBLIC SQUARE
Company's City: CLEVELAND
Company's State: OH
Company's Country: US
Company's Zip Code: 44114-2375
Company's Emerg Ph #: 800-424-9300(CHEMTREC)
Company's Info Ph #: 800-321-8642; 216-586-8023
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SMJ
Date MSDS Prepared: 25APR95
Safety Data Review Date: 03FEB98
MSDS Serial Number: CGCVB

=====
Ingredients/Identity Information
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Proprietary: NO
Ingredient: GASOLINE (MAY CONTAIN INGREDIENTS 2-11) % WT: 99.99-100
Ingredient Sequence Number: 01
Percent: <100
NIOSH (RTECS) Number: LX3300000
CAS Number: 8006-61-9
OSHA PEL: 300 PPM
ACGIH TLV: 300 PPM; 500 STEL

Proprietary: NO
Ingredient: TOLUENE (SARA 313) (CERCLA)
Ingredient Sequence Number: 02
Percent: 10-12
NIOSH (RTECS) Number: XS5250000
CAS Number: 108-88-3
OSHA PEL: 200 PPM
ACGIH TLV: 50 PPM, S

Proprietary: NO
Ingredient: PENTANE
Ingredient Sequence Number: 03
Percent: 9-11
NIOSH (RTECS) Number: RZ9450000
CAS Number: 109-66-0

N0007822

OSHA EL: 1000 PPM
ACGIH TLV: 600 PPM; 750 STEL

Proprietary: NO
Ingredient: XYLENE (SARA 313) (CERCLA)
Ingredient Sequence Number: 04
Percent: 6-10
NIOSH (RTECS) Number: ZE2100000
CAS Number: 1330-20-7
OSHA PEL: 100 PPM
ACGIH TLV: 100 PPM; 150 STEL

Proprietary: NO
Ingredient: HEXANE (CERCLA)
Ingredient Sequence Number: 05
Percent: 8-10
NIOSH (RTECS) Number: MN9275000
CAS Number: 110-54-3
OSHA PEL: 500 PPM
ACGIH TLV: 50 PPM

Proprietary: NO
Ingredient: HEPTANE (C7 & HIGHER)
Ingredient Sequence Number: 06
Percent: 6-8
NIOSH (RTECS) Number: MI7700000
CAS Number: 142-82-5
OSHA PEL: 500 PPM
ACGIH TLV: 400 PPM; 500 STEL

Proprietary: NO
Ingredient: BUTANE
Ingredient Sequence Number: 07
Percent: 4-6
NIOSH (RTECS) Number: EJ4200000
CAS Number: 106-97-8
OSHA PEL: 800 PPM
ACGIH TLV: 800 PPM

Proprietary: NO
Ingredient: BENZENE (SARA 313) (CERCLA)
Ingredient Sequence Number: 08
Percent: 0-3
NIOSH (RTECS) Number: CY1400000
CAS Number: 71-43-2
OSHA PEL: N/K (FP N)
ACGIH TLV: 10 PPM

Proprietary: NO
Ingredient: BENZENE, 1,2,4-TRIMETHYL-; (1,2,4-TRIMETHYLBENZENE) (SARA 313)
Ingredient Sequence Number: 09

Perc : 0-3
 NIOSH (RTECS) Number: DC3325000
 CAS Number: 95-63-6
 OSHA PEL: 25 PPM
 ACGIH TLV: 25 PPM

 Proprietary: NO
 Ingredient: BENZENE, ETHYL-; (ETHYLBENZENE) (SARA 313)
 Ingredient Sequence Number: 10
 Percent: 0-2
 NIOSH (RTECS) Number: DA0700000
 CAS Number: 100-41-4
 OSHA PEL: 100 PPM
 ACGIH TLV: 100 PPM; 125 STEL

 Proprietary: NO
 Ingredient: CYCLOHEXANE (SARA 313) (CERCLA)
 Ingredient Sequence Number: 11
 Percent: 1
 NIOSH (RTECS) Number: GU6300000
 CAS Number: 110-82-7
 OSHA PEL: 300 PPM
 ACGIH TLV: 300 PPM

 Proprietary: NO
 Ingredient: SUPDAT: EXPLODE IN HEAT OF FIRE. IRRIT OR TOX SUBSTANCES MAY
 BE EMITTED UPON THERMAL DECOMP.
 Ingredient Sequence Number: 12
 NIOSH (RTECS) Number: 9999999ZZ
 OSHA PEL: NOT APPLICABLE
 ACGIH TLV: NOT APPLICABLE

 Proprietary: NO
 Ingredient: EXPLAN OF CARCIN: ANNUAL REPORT ON CARCINS: 1994:KNOWN TO BE
 CARCIN. OSHA REGULATED: CFR 29 1910.1028.
 Ingredient Sequence Number: 13
 NIOSH (RTECS) Number: 9999999ZZ
 OSHA PEL: NOT APPLICABLE
 ACGIH TLV: NOT APPLICABLE

 Proprietary: NO
 Ingredient: EFTS OF OVEREXP:INHAL:MAY CAUSE RESP TRACT IRRIT & CNS SYMPS
 SIMILAR TO INGEST. MAY CAUSE IRREGULAR HEART RHYTHM(ING 15)
 Ingredient Sequence Number: 14
 NIOSH (RTECS) Number: 9999999ZZ
 OSHA PEL: NOT APPLICABLE
 ACGIH TLV: NOT APPLICABLE

 Proprietary: NO
 Ingredient: ING 14:& BEHAVIORAL CHG. CHRONIC:TOLUENE APPEARS ON NAVY LIST
 OF OCCUP CHEM REPRO HAZS. SEEK CONSULT FROM APPROP(ING 16)

Ingredient Sequence Number: 15
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 15: HLTH PROFESSIONALS CONCERNING LATEST HAZ LIST & SAFE
HNDLG & EXPOS INFO (FP N). SOLV "SNIFFING" OR (ING 17)
Ingredient Sequence Number: 16
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 16: INTENTIONAL PRLNGD OVEREXP TO HIGH LEVELS OF SOLV VAPS
CAN PRDCE ABNORM BEHAVIOR, CONVLS, HALLUCINATIONS, (ING 18)
Ingredient Sequence Number: 17
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 17: DELIRIUM, NERVOUS SYS DMG & SUDDEN DEATH. CONTACT NEHC
FOR MORE INFO ON HEALTH HAZARDS (FP N).
Ingredient Sequence Number: 18
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: FIRST AID: NOT BRTHG, ENSURE CLEAR AIRWAY & START CPR. IF
BRTHG IS DFCLT, ADMIN O*2 IF AVAIL. MONITOR CLOSELY. (ING 20)
Ingredient Sequence Number: 19
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 19: GET IMMED MED ATTN. NOTES TO MD: INGEST: MOST IMPORTANT
RISK TO ASSESS IS EXTENT OF ASPIR INTO LUNGS (ING 21)
Ingredient Sequence Number: 20
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE
ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 20: SINCE ACUTE CHEM PNEUMIT CAN RAPIDLY PROGRESS TO RESP
FAILURE. GASPING, COUGH & CHOKING ARE PRESUMPTIVE (ING 22)
Ingredient Sequence Number: 21
NIOSH (RTECS) Number: 9999999ZZ
OSHA PEL: NOT APPLICABLE

ACG TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 21: EVID OF ASPIR. SUGGEST ALL PATIENTS SUSPECTED OF HYDROCARB ASPIR HAVE BASE LINE CHEST X-RAY. CONSIDER (ING 23)

Ingredient Sequence Number: 22

NIOSH (RTECS) Number: 9999999ZZ

OSHA PEL: NOT APPLICABLE

ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 22: IMMED HOSPITALIZATION FOR ASYMPTOMATIC CHILDREN W/ ABNORM CHEST X-RAY, OBTUNDED OR HYPOXIC PATIENTS, (ING 24)

Ingredient Sequence Number: 23

NIOSH (RTECS) Number: 9999999ZZ

OSHA PEL: NOT APPLICABLE

ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 23: INTENTIONAL/MASSIVE INGESTS & PATIENTS W/ABNORM CHEST X-RAYS W/CLINICALLY SIGNIFICANT PULM DISEASE. GI (ING 25)

Ingredient Sequence Number: 24

NIOSH (RTECS) Number: 9999999ZZ

OSHA PEL: NOT APPLICABLE

ACGIH TLV: NOT APPLICABLE

Proprietary: NO

Ingredient: ING 24: SYMPS ARE USUALLY MINOR & PATHOLOGICAL CHGS OF LIVER & KIDNEY REPORTED UNCOMMON IN ACUTE INTOXICATIONS.

Ingredient Sequence Number: 25

NIOSH (RTECS) Number: 9999999ZZ

OSHA PEL: NOT APPLICABLE

ACGIH TLV: NOT APPLICABLE

Physical/Chemical Characteristics

Appearance And Odor: CLEAR LIQUID WITH A STRONG HYDROCARBON ODOR.

Boiling Point: >80F, >27C

Melting Point: N/A

Vapor Pressure (MM Hg/70 F): 760 @ 100F

Vapor Density (Air=1): 1.2

Specific Gravity: 0.72-0.74

Evaporation Rate And Ref: >1 (H*20=1)

Solubility In Water: NEGLIGIBLE

Percent Volatiles By Volume: 100

Fire and Explosion Hazard Data

Flash Point: -35F, -37C

Flash Point Method: TCC

Lower Explosive Limit: 1.4%

Upper Explosive Limit: 7.6%
Extinguishing Media: USE DRY CHEMICAL, ALCOHOL FOAM, ALL PURPOSE AFFF OR CARBON DIOXIDE TO EXTINGUISH FIRE.
Special Fire Fighting Proc: USE NIOSH APPRVD SCBA & FULL PROT EQUIP (FP N). WATER MAY BE INEFFECTIVE BUT SHOULD BE USED TO COOL FIRE-EXPOS CNTNRS, STRUCTURES & TO PROTECT PERS. IF (SUPDAT)
Unusual Fire And Expl Hazrds: DANGEROUS WHEN EXPOS TO HEAT/FLAME. VAPS FORM FLAM/EXPLO MIXS W/AIR AT ROOM TEMP. VAP/GAS MAY SPREAD TO DISTANT IGNIT SOURCE & FLASH BACK. VAPS MAY CONC(SUPDAT)

Reactivity Data

Stability: YES
Cond To Avoid (Stability): STABLE UNDER CONDITIONS OF NORMAL USE.
Materials To Avoid: AVOID CONTACT WITH STRONG OXIDIZERS.
Hazardous Decomp Products: COMBUSTION MAY PRODUCE CARBON MONOXIDE, CARBON DIOXIDE AND REACTIVE HYDROCARBONS.
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT

Health Hazard Data

LD50-LC50 Mixture: NONE SPECIFIED BY MANUFACTURER.
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INGEST:ASPIR INTO LUNGS MAY CAUSE PNEUMIT. MAY CAUSE GI DISTURBS. SYMPS INCL IRRIT, NAUS, VOMIT & DIARR. MAY CAUSE HARMFUL CNS EFTS; MAY INCL EXCITATION, EUPHORIA, HDCH, DIZZ, DROW, BLURRED SLIGHT IRRIT. RPTD/PRLNGD CNTCT MAY CAUSE (EFTS OF OVEREXP)
Carcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
Carcinogenicity - OSHA: YES
GROUP 2B. BENZENE: IARC MONO, VOL 7, PG 120, 1987:GROUP 1. NTP 7TH (ING 13)
Signs/Symptoms Of Overexp: HLTH HAZ: DEFAT, REDNESS, ITCH, INFLAM, CRACKING & POSS BURNS & SECONDARY INFECTION. HIGH PRESS SKIN INJECTIONS ARE SERIOUS MED EMERS. INJURY MAY NOT APPEAR SERIOUS AT FIRST; W/IN FEW HRS, TISS BECOMES SWOLLEN, DISCOLORED & EXTREMELY PAINFUL. EYES:MAY CAUSE IRRIT, REDNESS, PAIN, BLURRED VISION, LACRIM & CONJ. (ING 14)
Med Cond Aggravated By Exp: NONE SPECIFIED BY MANUFACTURER.
Emergency/First Aid Proc: INGEST:DO NOT INDUCE VOMIT; ASPIR DANGER. GET REMOVE CONTAMD CLTHG IMMED. WASH AREA W/SOAP & WATER. GET MED ATTN IF IRRIT PERSISTS. HIGH PRESS SKIN INJECTIONS REQ IMMED MED CARE. EYES:FLUSH IMMED W/LG AMTS OF WATER FOR AT LST 15 MIN. HOLD LIDS AWAY FROM EYEBALL. GET MED ATTN IF IRRIT RSLTS. INHAL:REMOVE FROM EXPOS. IF (ING 19)

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: SHUT OFF IGNIT SOURCE. STOP LEAK IF W/OUT RISK. WATER SPRAY MAY REDUCE VAP BUT MAY NOT PVNT IGNIT IN CLSD SPACES. SM SPILL:TAKE UP W/NONCOMBUST ABSORB & PLACE INTO CNTNRS. LG SPILL:DIKE FAR

AHEA OF LIQ SPILL. CNTCT NEHC FOR MORE INFO (FP N).

Neutralizing Agent: NONE SPECIFIED BY MANUFACTURER.

Waste Disposal Method: CHECK 40 CFR 261 TO DETERMINE WHETHER THIS SUBSTANCE IS HAZARDOUS WASTE. TRANSPORTATION, STORAGE, TREATMENT & DISPOSAL OF THIS WASTE MATERIAL MUST BE CONDUCTED IN COMPLIANCE W/ALL APPLIC FEDERAL, STATE & LOCAL REGS. FOR MORE INFO CNTCT NEHC (FP N).

Precautions-Handling/Storing: STORE ONLY IN APPRVD, CLEARLY LABELED CNTNRS (NEVER IN GLASS/UNAPPRVD PLASTIC CNTNRS); TIGHTLY CLSD IN COOL, DRY, ISOLATED, WELL-VENTD AREA.

Other Precautions: DO NOT SIPHON PROD BY MOUTH. USE ONLY AS MOTOR FUEL; NOT FOR CLEANING, PRESS APPLIANCE FUEL/ANY OTHER USE. KEEP OUT OF REACH OF CHILDREN. EMPTY CNTNRS MAY CNTN TOX, FLAM, COMBUST, EXPLO RESIDUE/VAPS. CONTACT NEHC FOR MORE INFO (FP N).

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Control Measures
=====

Respiratory Protection: IF EXPOS LIMS ARE EXCEEDED OR IRRIT IS EXPERIENCED, NIOSH APPRVD RESP PROT SHOULD BE WORN. VENT & OTHER FORMS OF ENGINEERING CTS ARE OFTEN PREF MEANS FOR CONTROLLING CHEM EXPOS. RESP PROT MAY BE NEEDED FOR NON-ROUTINE OR EMER SITUATIONS.

Ventilation: NONE SPECIFIED BY MANUFACTURER.

Protective Gloves: IMPERVIOUS GLOVES.

Eye Protection: ANSI APPRVD CHEM WORKERS GOGGLES (FP N).

Other Protective Equipment: ANSI APPROVED EYE WASH & DELUGE SHOWER (FP N). AVOID SKIN CONTACT. WEAR PROT CLTHG. DO NOT WEAR CNTCT LENSES.

Work Hygienic Practices: WASH HANDS IF IN CNTCT W/MATL. USE GOOD PERSONAL HYGIENE. WEAR REGULARLY CLEANED WORK CLTHG. SHOWER & CHANGE AFTER WORK.

Suppl. Safety & Health Data: FIRE FIGHT PROC: LEAK/SPILL HAS NOT IGNITED, VENT AREA & USE WATER SPRAY TO DISPERSE GAS/VAP & PROTECT PERS. USE WATER TO DULUTE SPILLS & FLUSH THEM AWAY FROM IGNIT SOURCE. DO NOT FLUSH DOWN PUBLIC SEWERS/OTHER DRAIN SYS. EXPLO HAZ: IN CONFINED AREAS. RUNOFF TO SEWER MAY CAUSE FIRE/EXPLO HAZ. CNTNRS MAY (ING 12)

=====
Transportation Data
=====

=====
Disposal Data
=====

=====
Label Data
=====

Label Required: YES

Technical Review Date: 03FEB98

Label Date: 29JAN98

Label Status: G

Common Name: GASOLINE, BP REGULAR UNLEADED

Chronic Hazard: YES

Signal Word: DANGER!

Acute Health Hazard-Moderate: X

Contact Hazard-Moderate: X

Fire Hazard-Severe: X

N0007828

Reactivity Hazard-None: X

Special Hazard Precautions: FLAMMABLE. ACUTE: INGEST: ASPIRATION INTO LUNGS MAY CAUSE PNEUMIT. MAY CAUSE GI DISTURBS. SYMPTOMS INCL IRRIT, NAUSEA, VOMIT & DIARR. MAY CAUSE HARMFUL CNS EFTS; MAY INCL EXCITATION, EUPHORIA, HEADACHE, DIZZ, DROW, BLURRED VISION, FATIGUE, TREMORS, CONVLS, UNCON, COMA, RESP ARREST & DEATH. SKIN: SLIGHT IRRIT. EYES: SLIGHT IRRIT. MAY CAUSE REDNESS, PAIN, BLURRED VISION, LACRIMATION & CONJ. INHAL: MAY CANCER HAZARD. GASOLINE IS LISTED AS AN ANIMAL LUNG CARCINOGEN. CONTAINS BENZENE WHICH IS LISTED AS A HUMAN LUNG CARCINOGEN (FP N). MAY ADVERSELY EFFECT LIVER & KIDNEY.

Protect Eye: Y

Protect Skin: Y

Protect Respiratory: Y

Label Name: BP OIL CO

Label Street: 200 PUBLIC SQUARE

Label City: CLEVELAND

Label State: OH

Label Zip Code: 44114-2375

Label Country: US

Label Emergency Number: 800-424-9300 (CHEMTREC)

Please reduce your browser font size for better viewing and printing.

MSDS**Material Safety Data Sheet**

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response In Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

HYDROCHLORIC ACID, 33 - 40%

MSDS Number: H3880 --- *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Muriatic acid; hydrogen chloride, aqueous

CAS No.: 7647-01-0

Molecular Weight: 36.46

Chemical Formula: HCl

Product Codes:

J.T. Baker: 5367, 5537, 5575, 5800, 5814, 5839, 6900, 7831, 9529, 9530, 9534, 9535, 9536, 9537, 9538, 9539, 9540, 9544, 9548

Mallinckrodt: 2062, 2612, 2624, 2626, 5587, H611, H613, H987, H992, H999, V078, V628

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hydrogen Chloride	7647-01-0	33 - 40%	Yes
Water	7732-18-5	60 - 67%	No

N0007830

3. Hazards Identification

Emergency Overview

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)

Flammability Rating: 0 - None

Reactivity Rating: 2 - Moderate

Contact Rating: 3 - Severe (Corrosive)

Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

Storage Color Code: White (Corrosive)

Potential Health Effects

Inhalation:

Corrosive! Inhalation of vapors can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory failure, and death.

Ingestion:

Corrosive! Swallowing hydrochloric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract. May cause nausea, vomiting, and diarrhea. Swallowing may be fatal.

Skin Contact:

Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and discolor skin.

Eye Contact:

Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

Chronic Exposure:

Long-term exposure to concentrated vapors may cause erosion of teeth. Long term exposures seldom occur due to the corrosive properties of the acid.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders or eye disease may be more susceptible to the effects of this substance.

4. First Aid Measures

Inhalation:

move to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Extreme heat or contact with metals can release flammable hydrogen gas.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

If involved in a fire, use water spray. Neutralize with soda ash or slaked lime.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Structural firefighter's protective clothing is ineffective for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker NEUTRASORB(R) or TEAM(R) 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. When opening metal containers, use non-sparking tools because of the possibility of hydrogen gas being present. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):

5 ppm Ceiling

-ACGIH Threshold Limit Value (TLV):

5 ppm Ceiling

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a full facepiece respirator with an acid gas cartridge may be worn up to 50 times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. WARNING: Air purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Colorless, fuming liquid.

Odor:

ingent odor of hydrogen chloride.

Solubility:

Infinite in water with slight evolution of heat.

Density:

1.18

pH:

For HCL solutions: 0.1 (1.0 N), 1.1 (0.1 N), 2.02 (0.01 N)

% Volatiles by volume @ 21C (70F):

100

Boiling Point:

53C (127F) Azeotrope (20.2%) boils at 109C (228F)

Melting Point:

-74C (-101F)

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

190 @ 25C (77F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage. Containers may burst when heated.

Hazardous Decomposition Products:

When heated to decomposition, emits toxic hydrogen chloride fumes and will react with water or steam to produce heat and toxic and corrosive fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

A strong mineral acid, concentrated hydrochloric acid is incompatible with many substances and highly reactive with strong bases, metals, metal oxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, and formaldehyde.

Conditions to Avoid:

Heat, direct sunlight.

11. Toxicological Information

N0007834

Inhalation rat LC50: 3124 ppm/1H; oral rabbit LD50: 900 mg/kg (Hydrochloric acid concentrated); investigated as a

morigen, mutagen, reproductive effector.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Hydrogen Chloride (7647-01-0)	No	No	3
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:

When released into the soil, this material is not expected to biodegrade. When released into the soil, this material may leach into groundwater.

Environmental Toxicity:

This material is expected to be toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: HYDROCHLORIC ACID

Hazard Class: 8

UN/NA: UN1789

Packing Group: II

Information reported for product/size: 475LB

International (Water, I.M.O.)

Proper Shipping Name: HYDROCHLORIC ACID

Hazard Class: 8

N0007835

√/NA: UN1789
Packing Group: II
Information reported for product/size: 475LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Hydrogen Chloride (7647-01-0) Yes Yes Yes Yes
Water (7732-18-5) Yes Yes Yes Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea DSL NDSL Phil.

Hydrogen Chloride (7647-01-0) Yes Yes No Yes
Water (7732-18-5) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
Ingredient -SARA 302- -SARA 313-----
RQ TPQ List Chemical Catg.

Hydrogen Chloride (7647-01-0) 5000 500* Yes No
Water (7732-18-5) No No No No

-----\Federal, State & International Regulations - Part 2\-----
Ingredient CERCLA -RCRA- -TSCA-
261.33 8(d)

Hydrogen Chloride (7647-01-0) 5000 No No
Water (7732-18-5) No No No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: Yes
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2R
Poison Schedule: No information found.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0

Label Hazard Warning:

POISON! DANGER! CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG DAMAGE.

Label Precautions:

Do not get in eyes, on skin, or on clothing.

Do not breathe vapor or mist.

Use only with adequate ventilation.

Wash thoroughly after handling.

Store in a tightly closed container.

Remove and wash contaminated clothing promptly.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

No changes.

Disclaimer:

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

N0007837



DOD Hazardous Material Information
DOD 6050.5-L
As of April 1997

This information prepared for Cornell University convenience only.

HGX MERCURY DECONTAMINANT POWDER

FSC: 6850

NIIN: 012308556

NSN: 68500123085561

MANUFACTURERS CAGE: 18078

PART NO INDICATOR: B

PART NUMBER TRADE NAME: HGX MERCURY DECONTAMINANT POWDER

Nuclear Water Data

NUCLEAR WATER FSC: DECO

NUCLEAR WATER NIIN: NTAMINATI

NUCLEAR WATER COG: NG

NUCLEAR WATER NOMENCLATURE: AGENT, MERCURY

N0007838

NUCLEAR WATER REMARKS: ACTON TECH

Standard PMS Identification Data

SPIN FSC: NOLO

SPIN NIIN: GIES INC.

SPIN:

General Information

ITEM NAME: 100 THOMPSON ST.

MANUFACTURERS NAME: 726 PITTSTON PA

MANUFACTURERS STREET: US18640-1437717-654-0612

MANUFACTURERS P O BOX:

MANUFACTURERS CITY: 717-654-0612 ACTI

MANUFACTURERS STATE: ON

MANUFACTURERS COUNTRY: T

MANUFACTURERS ZIP CODE: ECHNOLOGIE

MANUFACTURERS EMERG PH: S INC (717-654-0612) 0CSL0

MANUFACTURERS INFO PH:

DISTRIBUTOR VENDOR 1:

DISTRIBUTOR VENDOR 1 CAGE:

DISTRIBUTOR VENDOR 2:

N0007839

DISTRIBUTOR VENDOR 2 CAGE:

DISTRIBUTOR VENDOR 3: D 002002SM 01AUG9431DEC94CX

DISTRIBUTOR VENDOR 3 CAGE:

DISTRIBUTOR VENDOR 4:

DISTRIBUTOR VENDOR 4 CAGE:

SAFETY DATA ACTION CODE:

SAFETY FOCAL POINT:

RECORD NO FOR SAFETY ENTRY:

TOT SAFETY ENTRIES THIS STK:

STATUS:

DATE MSDS PREPARED:

SAFETY DATA REVIEW DATE:

SUPPLY ITEM MANAGER:

MSDS PREPARERS NAME:

PREPARERS COMPANY:

PREPARERS ST OR P O BOX:

PREPARERS CITY: BMDWCNONE NONE

PREPARERS STATE:

PREPARERS ZIP CODE: N1

OTHER MSDS NUMBER: CNUNKNOWN PPP-C-96 1.5 LBS

N0007840

MSDS SERIAL NUMBER: NONE

SPECIFICATION NUMBER: NO

SPEC TYPE GRADE CLASS: NE GRANULAR (WH

HAZARD CHARACTERISTIC CODE: ITE),

UNIT OF ISSUE: N

UNIT OF ISSUE CONTAINER QTY: O ODOR.

TYPE OF CONTAINER:

NET UNIT WEIGHT:

NRC STATE LICENSE NUMBER:

NET EXPLOSIVE WEIGHT:

NET PROPELLANT WEIGHT AMMO: UNKNO

COAST GUARD AMMUNITION CODE: WN

Physical & Chemical Characteristics

APPEARANCE AND ODOR: UNKNOWN UNKNOWN N/A EST. >1.0 UNKNOWN N/A

BOILING POINT: APPREC

MELTING POINT: IABLE.

VAPOR PRESSURE MM HG 70 F: N/K

VAPOR DENSITY AIR 1:

SPECIFIC GRAVITY: N/K

DECOMPOSITION TEMPERATURE:

EVAPORATION RATE AND REF: N/P UNKNOWN N/A NOT

SOLUBILITY IN WATER: APPLICABLE N/P NO

PERCENT VOLATILES BY VOLUME: T FLAM

VISCOSITY: MABLNOT FLAMM

PH: ABLNOT

RADIOACTIVITY: APPLICABLE

FORM RADIOACTIVE MATL:

MAGNETISM MILLIGAUSS:

CORROSION RATE IPY:

AUTOIGNITION TEMPERATURE:

Fire and Explosion Hazard Data

FLASH POINT:

FLASH POINT METHOD:

LOWER EXPLOSIVE LIMIT:

UPPER EXPLOSIVE LIMIT:

EXTINGUISHING MEDIA: EXTREMELY HIGH TEMPERATURES MAY CAUSE EVOLUTION OF TOXIC SULFUR DIOXIDE AND HYDROGEN SUL

SPECIAL FIRE FIGHTING PROC: FIDE GASES. SUPPLIER DID NOT ADDRESS THIS FIELD.

UNUSUAL FIRE AND EXPL HAZRDS: YESSTABILITY LIMITED IN SOLUTION. HIGH TEMPERATURES.

Reactivity Data

STABILITY:

COND TO AVOID STABILITY: ACIDS AND OXIDIZING AGENTS.

MATERIALS TO AVOID: HIGH TEMPERATURES (800-900F) MAY CAUSE EVOLUTION OF TOXIC SULFUR DIOXIDE AND HYDROGEN SU

HAZARDOUS DECOMP PRODUCTS: LFIDE GASES. NO WILL NOT OCCUR.

HAZARDOUS POLY OCCUR:

CONDITIONS TO AVOID POLY: ORAL LD50 (RAT) IS UNKNOWN YESYESYESSUPPLIER DID NOT ADDRESS THIS FIELD.

Health Hazard Data

LD50 LC50 MIXTURE:

ROUTE OF ENTRY INHALATION:

ROUTE OF ENTRY SKIN:

ROUTE OF ENTRY INGESTION:

HEALTH HAZ ACUTE AND CHRONIC: NO NO NO MFR LISTED NO INFORMATION ABOUT THE CARCINOGENICITY OF THI

CARCINOGENICITY NTP: S MATERIAL

CARCINOGENICITY IARC: . HMIS DOE

CARCINOGENICITY OSHA: S NOT EXPE

EXPLANATION CARCINOGENICITY: CT IT TO BE CARCINOGENIC. NONE KNOWN.

SIGNS SYMPTOMS OF OVEREXP: SUPPLIER DID NOT ADDRESS THIS FIELD.

N0007843

MED COND AGGRAVATED BY EXP: INHALATION: AVOID BREATHING DUST BY WEARING DUST RESPIRATOR. REMOVE TO FRESH AIR IF EFFECT

EMERGENCY FIRST AID PROC: TS OCCUR. EYES: IRRIGATE EYES FOR 15 MINUTES. FOR SERIOUS IRRITATION, SEEK MEDICAL ATTENTION. SKIN: FLUSH SKIN WITH WATER FOR 15 MIN. FOR SERIOUS IRRITATION, SEEK MEDICAL ATTENTION. INGESTED: INGESTION IN LARGE QUANTITIES COULD BE HARMFUL-SEEK MEDICAL ATTENTION. SWEEP UP AND REMOVE EXCESS. FLUSH RESIDUE WITH WATER.

Precautions for Safe Handling and Use

STEPS IF MATL RELEASED SPILL: MFR GAVE NO INFORMATION ON MSDS. UNUSED,

NEUTRALIZING AGENT: IN DRY FORM, THIS PRODUCT MAY BE STORED INDEFINITELY. IT MAY BE DISPOSED OF ACCORDING TO

WASTE DISPOSAL METHOD: ACCORDING TO LOCAL, STATE AND FEDERAL REGULATIONS. SEE SUPP DATA FOR DIRECTIONS ON USED HGX. STORE IN A COOL, DRY AREA. AVOID STORAGE WHERE CONTACT WITH ACIDS OR OXIDIZING AGENTS ARE

PRECAUTIONS HANDLING STORING: NONE LIKELY. AVOID BREATHING DUST. AVOID SKIN AND EYE CONTACT.

OTHER PRECAUTIONS: SUPPLIER DID NOT ADDRESS THIS FIELD.

Control Measures

RESPIRATORY PROTECTION: AS NECESSARY TO REMOVE DUST.

VENTILATION: RECOMMENDED. SAFETY GLASSES WITH SIDE SHIELDS. WEAR CLOTHING

PROTECTIVE GLOVES: THING SUFFICIENT TO PROTECT SKIN FROM CONTACT

EYE PROTECTION: CONTACT.

OTHER PROTECTIVE EQUIPMENT: MFR: ? HMIS: USE STRICT CHEMICAL HYGIENE PRACTICE. AVOID UNNECESSARY EXPOSURE. WASH THOROUGHLY

WORK HYGIENIC PRACTICES: UGHLY BEFORE EATING OR DRINKING. HGX WHICH HAS BEEN USED TO DECONTAMINATE A MERCURY SPILL MUST BE HANDLED AS FOLLOWS: SEPARATELY

SUPPL SAFETY HEALTH DATA: ARATE SOLIDS & DO A TOXICITY TEST ON THE SOLIDS & THE LIQUIDS. DEPENDING ON THE TOXICITY READINGS, ADD MORE HGX TO FURTHER DECONTAMINATE THE LIQUID OR SOLIDS WHICH CAN THEN BE DISPOSED OF I/A/W FEDERAL, STATE & LOCAL REGULATIONS. D 94365ZZZ N/R NOT REGULATED BY THIS MODE OF TRANSPORTATION

Transportation Data

TRANSPORTATION ACTION CODE:

TRANSPORTATION FOCAL POINT:

TRANS DATA REVIEW DATE:

DOT PSN CODE:

DOT SYMBOL:

DOT PROPER SHIPPING NAME: N/R N/R N/R N/R ZZZ NOT REGULA

DOT CLASS: TED FOR T

DOT ID NUMBER: HIS MOD

DOT PACK GROUP: E OF TRA

DOT LABEL: NSPORTATION

DOT DOD EXEMPTION NUMBER:

IMO PSN CODE:

IMO PROPER SHIPPING NAME: N/R N/R N/R N/R ZZZ N/R NOT REGULATED BY THIS MODE OF TR

IMO REG PAGE NUMBER: ANSPORTAT

IMO UN NUMBER: ION

IMO UN CLASS:

IMO SUBSID RISK LABEL:

IATA PSN CODE:

IATA UN ID NUMBER:

IATA PROPER SHIP NAME: N/R N/R N/R ZZZ NOT REGULATED BY THIS MODE OF TRANSPORT

IATA UN CLASS: ATIO

IATA SUBSID RISK CLASS: N

IATA LABEL:

AFI PSN CODE:

AFI SYMBOLS:

AFI PROP SHIPPING NAME: N/R N/R N/R N/R

AFI CLASS:

AFI ID NUMBER:

AFI PACK GROUP:

AFI LABEL:

AFI SPECIAL PROV:

AFI BASIC PAC REF:

MMAC CODE:

N O S SHIPPING NAME:

ADDITIONAL TRANS DATA:

Disposal Data

DISPOSAL DATA ACTION CODE:

DISPOSAL DATA FOCAL POINT:

DISPOSAL DATA REVIEW DATE:

RECNUM FOR THIS DISP ENTR:

TOT DISP ENTRIES PER NSN:

LANDFILL BAN ITEM:

DISPOSAL SUPPLEMENTAL DAT:

EPAHAZWST 1ST CODE NEW:

EPAHAZWST 1ST NAME NEW:

EPAHAZWST 1ST CHAR NEW:

EPAACUTEHAZARD 1ST NEW:

EPAHAZWST 2ND CODE NEW:

EPAHAZWST 2ND NAME NEW:

EPAHAZWST 2ND CHAR NEW:

EPAACUTEHAZARD 2ND NEW:

EPAHAZWST 3RD CODE NEW:

EPAHAZWST 3RD NAME NEW: YES31DEC94 NONE F HGX MERCURY DECONTAMINANT

EPAHAZWST 3RD CHAR NEW: POWDER

EPAACUTE 3RD HAZARD NEW:

N0007847

Label Data

LABEL REQUIRED:

TECHNICAL REVIEW DATE: N/P

LABEL DATE: CAUTION

MFR NUMBER: ! X X X X

LABEL STATUS: *

COMMON NAME: *TARGET ORGANS:NONE** STORE IN A COOL, DRY AREA. AVOID STORA

CHRONIC HAZARD: GE

SIGNAL WORD: WHERE CO

ACUTE HEALTH HAZARD NONE: N

ACUTE HEALTH HAZARD SLIGHT: T

ACUTE HEALTH HAZARD MODERATE: A

ACUTE HEALTH HAZARD SEVERE: C

CONTACT HAZARD NONE: T

CONTACT HAZARD SLIGHT:

CONTACT HAZARD MODERATE: W

CONTACT HAZARD SEVERE: I

FIRE HAZARD NONE: T

FIRE HAZARD SLIGHT: H

N0007848

FIRE HAZARD MODERATE:

FIRE HAZARD SEVERE: A

REACTIVITY HAZARD NONE: C

REACTIVITY HAZARD SLIGHT: I

REACTIVITY HAZARD MODERATE: D

REACTIVITY HAZARD SEVERE: S

SPECIAL HAZARD PRECAUTIONS: OR OXIDIZING AGENTS ARE LIKELY. IN CASE OF SPILL: SWEEP UP AND REMOVE EXCESS. FLUSH RESIDUE WITH WATER. YY ACTON TECHNOLOGIES INC. 100 THOMPSON ST.

PROTECT EYE:

PROTECT SKIN:

PROTECT RESPIRATORY:

LABEL NAME: 726 PITTSTON PA

LABEL STREET: 18640-1437US717-654-0612

LABEL P O BOX:

LABEL CITY: 1995

LABEL STATE:

LABEL ZIP CODE:

LABEL COUNTRY:

LABEL EMERGENCY NUMBER:

YEAR PROCURED:

FIRE HAZARD SEVERE: A

N0007849

REACTIVITY HAZARD NONE: C

REACTIVITY HAZARD SLIGHT: I

REACTIVITY HAZARD MODERATE: D

REACTIVITY HAZARD SEVERE: S

SPECIAL HAZARD PRECAUTIONS: OR OXIDIZING AGENTS ARE LIKELY. IN CASE OF SPILL: SWEEP UP AND REMOVE EXCESS. FLUSH RESIDUE WITH WATER. YY ACTON TECHNOLOGIES INC. 100 THOMPSON ST.

PROTECT EYE:

PROTECT SKIN:

PROTECT RESPIRATORY:

LABEL NAME: 726 PITTSTON PA

LABEL STREET: 18640-1437US717-654-0612

LABEL P O BOX:

LABEL CITY: 1995

LABEL STATE:

LABEL ZIP CODE:

LABEL COUNTRY:

LABEL EMERGENCY NUMBER:

YEAR PROCURED:

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MSDS**Material Safety Data Sheet**

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT

24 Hour Emergency Telephone: 908-858-2151
CHEMTREC: 1-800-424-9300

National Response In Canada
CANUTEC: 613-898-6666

Outside U.S. and Canada
Chemtec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

MERCURY

MSDS Number: M1599 --- *Effective Date: 11/17/99*

1. Product Identification

Synonyms: Quicksilver; hydrargyrum; Liquid Silver

CAS No.: 7439-97-6

Molecular Weight: 200.59

Chemical Formula: Hg

Product Codes:

J.T. Baker: 2564, 2567, 2569, 2572

Mallinckrodt: 1278, 1280, 1288

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Mercury	7439-97-6	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. CAUSES BURNS TO SKIN, EYES, AND RESPIRATORY TRACT. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. AFFECTS THE KIDNEYS AND CENTRAL NERVOUS SYSTEM. MAY CAUSE ALLERGIC SKIN REACTION.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 4 - Extreme (Poison)

Flammability Rating: 0 - None

Reactivity Rating: 1 - Slight

Contact Rating: 3 - Severe (Life)

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES

Storage Color Code: Blue (Health)

Potential Health Effects

Inhalation:

Mercury vapor is highly toxic via this route. Causes severe respiratory tract damage. Symptoms include sore throat, coughing, pain, tightness in chest, breathing difficulties, shortness of breath, headache, muscle weakness, anorexia, gastrointestinal disturbance, ringing in the ear, liver changes, fever, bronchitis and pneumonitis. Can be absorbed through inhalation with symptoms similar to ingestion.

Ingestion:

May cause burning of the mouth and pharynx, abdominal pain, vomiting, corrosive ulceration, bloody diarrhea. May be followed by a rapid and weak pulse, shallow breathing, paleness, exhaustion, tremors and collapse. Delayed death may occur from renal failure. Gastrointestinal uptake of mercury is less than 5% but its ability to penetrate tissues presents some hazard. Initial symptoms may be thirst, possible abdominal discomfort.

Skin Contact:

Causes irritation and burns to skin. Symptoms include redness and pain. May cause skin allergy and sensitization. Can be absorbed through the skin with symptoms to parallel ingestion.

Eye Contact:

Causes irritation and burns to eyes. Symptoms include redness, pain, blurred vision; may cause serious and permanent eye damage.

Chronic Exposure:

Chronic exposure through any route can produce central nervous system damage. May cause muscle tremors, personality and behavior changes, memory loss, metallic taste, loosening of the teeth, digestive disorders, skin rashes, brain damage and kidney damage. Can cause skin allergies and accumulate in the body. Repeated skin contact can cause the skin to turn gray in color. A suspected reproductive hazard; may damage the developing fetus and decrease fertility in males and females.

Aggravation of Pre-existing Conditions:

Persons with nervous disorders, or impaired kidney or respiratory function, or a history of allergies or a known sensitization to mercury may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard.

Explosion:

Not considered to be an explosion hazard.

Fire Extinguishing Media:

Use any means suitable for extinguishing surrounding fire. Do not allow water runoff to enter sewers or waterways.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Undergoes hazardous reactions in the presence of heat and sparks or ignition. Smoke may contain toxic mercury or mercuric oxide. Smoke may contain toxic mercury or mercuric oxide.

6. Accidental Release Measures

Ventilate area of leak or spill. Clean-up personnel require protective clothing and respiratory protection from vapor. Spills: Pick up and place in a suitable container for reclamation or disposal in a method that does not generate misting. Sprinkle area with sulfur or calcium polysulfide to suppress mercury. Do not flush to sewer. US Regulations (CERCLA) require reporting

spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker CINNASORB(R) and RESISORB(R) are recommended for spills of this product.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from any source of heat or ignition. Do not use or store on porous work surfaces (wood, unsealed concrete, etc.). Follow strict hygiene practices. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

- OSHA Acceptable Ceiling Concentration:

mercury and mercury compounds: 0.1 mg/m³ (TWA), skin

- ACGIH Threshold Limit Value (TLV):

inorganic and metallic mercury, as Hg: 0.025 mg/m³ (TWA) skin, A4 Not classifiable as a human carcinogen.

- ACGIH Biological Exposure Indices:

total inorganic mercury in urine (preshift): 35 ug/g creatinine;

total inorganic mercury in blood (end of shift): 15 ug/l.

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, a half-face respirator with a mercury vapor or chlorine gas cartridge may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece respirator with a mercury vapor or chlorine gas cartridge may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-

ench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Silver-white, heavy, mobile, liquid metal.

Odor:

Odorless.

Solubility:

Insoluble in water.

Density:

13.55

pH:

No information found.

% Volatiles by volume @ 21C (70F):

100

Boiling Point:

356.7C (675F)

Melting Point:

-38.87C (-38F)

Vapor Density (Air=1):

7.0

Vapor Pressure (mm Hg):

0.0018 @ 25C (77F)

Evaporation Rate (BuAc=1):

4

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

At high temperatures, vaporizes to form extremely toxic fumes.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Acetylenes, ammonia, ethylene oxide, chlorine dioxide, azides, metal oxides, methyl silane, lithium, rubidium, oxygen, strong oxidants, metal carbonyls.

Conditions to Avoid:

Heat, flames, ignition sources, metal surfaces and incompatibles.

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11. Toxicological Information

Toxicological Data:

Investigated as a tumorigen, mutagen, reproductive effector.

Reproductive Toxicity:

All forms of mercury can cross the placenta to the fetus, but most of what is known has been learned from experimental animals. See Chronic Health Hazards.

Carcinogenicity:

EPA / IRIS classification: Group D1 - Not classifiable as a human carcinogen.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	

Mercury (7439-97-6)	No	No	3

12. Ecological Information

Environmental Fate:

This material has an experimentally-determined bioconcentration factor (BCF) of greater than 100. This material is expected to significantly bioaccumulate.

Environmental Toxicity:

This material is expected to be toxic to aquatic life. The LC50/96-hour values for fish are less than 1 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: RQ, MERCURY
Hazard Class: 8
UN/NA: UN2809
Packing Group: III
Information reported for product/size: 2.5KG

International (Water, I.M.O.)

Proper Shipping Name: MERCURY
Hazard Class: 8
UN/NA: UN2809
Packing Group: III
Information reported for product/size: 2.5KG

International (Air, I.C.A.O.)

Proper Shipping Name: MERCURY
Hazard Class: 8
UN/NA: UN2809
Packing Group: III
Information reported for product/size: 2.5KG

15. Regulatory Information

Ingredient	TSCA	EC	Japan	Australia
Mercury (7439-97-6)	Yes	Yes	No	Yes

Ingredient	Korea	DSL	NDSL	Phil.
Mercury (7439-97-6)	Yes	Yes	No	Yes

Ingredient	-SARA 302- RQ	TPQ	-SARA 313- List	Chemical Catg.
Mercury (7439-97-6)	No	No	Yes	No

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)

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M ary (7439-97-6)

1

151

No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: No (Pure / Liquid)

WARNING:

THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: 2Z

Poison Schedule: S7

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0

Label Hazard Warning:

DANGER! CORROSIVE. CAUSES BURNS TO SKIN, EYES, AND RESPIRATORY TRACT. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. AFFECTS THE KIDNEYS AND CENTRAL NERVOUS SYSTEM. MAY CAUSE ALLERGIC SKIN REACTION.

Label Precautions:

Do not get in eyes, on skin, or on clothing.

Do not breathe vapor.

Keep container closed.

Use only with adequate ventilation.

Wash thoroughly after handling.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

No changes.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling

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the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

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MSDS**Material Safety Data Sheet**

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865



24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 813-998-6666

Outside U.S. and Canada
Chemtrec: 202-483-7616

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Mercury Indicator

MSDS Number: Z6056 --- *Effective Date: 06/01/98*

1. Product Identification

Synonyms: None

CAS No.: Not applicable to mixtures.

Molecular Weight: Not applicable to mixtures.

Chemical Formula: Proprietary Mixture

Product Codes: 4509

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Cuprous Iodide	7681-65-4	1 - 50%	Yes
Sulfur	7704-34-9	1 - 50%	Yes
Starch	9005-25-8	1 - 50%	Yes
Silica, Amorphous	7631-86-9	1 - 50%	Yes
Specific CAS No. for Silica, Amorphous is 112945-52-5 (Amorphous fumed silica)			

3. Hazards Identification

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. DUST MAY FORM FLAMMABLE OR EXPLOSIVE MIXTURE WITH AIR.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate

Flammability Rating: 0 - None

Reactivity Rating: 1 - Slight

Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT

Storage Color Code: Orange (General Storage)

Potential Health Effects

Amorphous fumed silica does not contain crystalline silica.

Inhalation:

May cause dryness and irritation to mucous membranes, nose, and throat. Symptoms may include coughing, sore throat, dyspnea, wheezing, and non-specific chest illnesses.

Ingestion:

Major hazard is that of the copper iodide component, of which only trace amounts are moderately toxic. Symptoms may include burning pain in the mouth, esophagus, and stomach. Symptoms of copper poisoning include hemorrhagic gastritis, nausea, vomiting, abdominal pain, metallic taste, and diarrhea.

Ingestion of very large amounts of sulfur may cause sore throat, nausea, headache, and possibly unconsciousness in severe cases. May be converted into hydrogen sulfide in the intestine.

Skin Contact:

Causes irritation to skin. Symptoms include redness, itching, and pain.

Eye Contact:

Causes irritation, redness, and pain.

Chronic Exposure:

Prolonged overexposure to sulfur dust can produce possible skin sensitization and permanent eye damage (clouding of the lens and chronic irritation). Prolonged inhalation can cause irritation of mucous membranes.

Chronic iodide overdoses have produced iodism. Headache, fever, sneezing, salivation, and skin rashes may occur. Prolonged or repeated exposure to dusts of copper salts may cause discoloration of the skin or hair, ulceration and perforation of the nasal septum, runny nose, metallic taste, and atrophic changes and irritation of the mucous membranes.

Aggravation of Pre-existing Conditions:

Sensitive individuals can experience skin irritation from repeated exposure to sulfur dust. Allergic responses can occur.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Flash point: 207C (405F) OC

Autoignition temperature: 232C (450F)

(Listed values are for sulfur.)

Slight fire hazard when exposed to heat or flame. As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source. Contact with strong oxidizers may cause fire.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Fire Extinguishing Media:

For fires involving sulfur, extinguish with dry chemical, sand, water spray, fog, or standard foam. If water is used, apply from as far a distance as possible. Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Solid streams of water should not be used because of possibility of dispersing dust clouds of sulfur in air.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

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Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container.

7. Handling and Storage

Keep in a tightly closed container. Store in a cool, dry, corrosion-proof, ventilated area away from moisture, sources of heat or ignition, combustibles and oxidizers. Protect against physical damage. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process capable of generating dust and/or static electricity. Empty only into inert or non-flammable atmosphere. Emptying contents into a non-inert atmosphere where flammable vapors may be present could cause a flash fire or explosion due to electrostatic discharge. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product. Do Not attempt to clean empty containers since residue is difficult to remove. Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, sparks, flame, static electricity or other sources of ignition: they may explode and cause injury or death.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

- OSHA Permissible Exposure Limit (PEL) -

Cuprous Iodide: 1 mg/m³ (TWA) for copper dusts & mists as Cu

Amorphous Fumed Silica (nuisance dust): 15 mg/m³ (total dust, TWA),
5mg/m³ (respirable fraction, TWA)

Starch: 15 mg/m³ (total dust, TWA),

5 mg/m³ (respirable fraction, TWA)

- ACGIH Threshold Limit Value (TLV) -

Cuprous Iodide: 1 mg/m³ (TWA) for copper dusts & mists as Cu

Amorphous Fumed Silica (dust containing no asbestos and < 1% crystalline silica for particulates not otherwise classified): 10
mg/m³ (total dust, TWA)

3 mg/m³ (respirable fraction, TWA)

Starch: 10 mg/m³ (TWA), A4-not classifiable as human carcinogen

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits.

Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

White to yellow solid.

Odor:

No information found.

Solubility:

Negligible.

Specific Gravity:

No information found.

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

No information found.

Melting Point:

No information found.

Vapor Density (Air=1):

Not applicable.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Burning may release hydrogen iodide or iodine vapors and oxides of sulfur and carbon.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

For Sulfur: chlorates, nitrates and other oxidizing agents. Halogens, carbides, zinc, tin, alkali metals, phosphorus, ammonia, ammonium nitrate, charcoal and many other substances.

For Cuprous Iodide: can explode when mixed with potassium or nitromethane. Copper salts promote the decomposition of hydrazine and sodium hypobromite; many form dangerous, explosive, acetylides.

For Amorphous Silica: hydrogen fluoride, fluorine, xenon hexafluoride, oxygen difluoride, and chlorine trifluoride. Substance can explode when wet and heated with magnesium.

Conditions to Avoid:

Heat, flame, ignition sources, dusting and incompatibles.

11. Toxicological Information

Toxicological Data:

For amorphous fumed silica: oral rat LD50: 3160 mg/kg. Investigated as a tumorigen and mutagen.

Carcinogenicity:

IARC category for silica, amorphous (7631-86-9) applies to silicas that may contain crystalline silica. The silica in this product is synthetic and does not contain crystalline silica.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Cuprous Iodide (7681-65-4)	No	No	None
Sulfur (7704-34-9)	No	No	None
Starch (9005-25-8)	No	No	None
Silica, Amorphous (7631-86-9)	No	No	3

12. Ecological Information

Environmental Fate:

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No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Cuprous Iodide (7681-65-4)	Yes	Yes	Yes	Yes
Sulfur (7704-34-9)	Yes	Yes	No	Yes
Starch (9005-25-8)	Yes	Yes	No	Yes
Silica, Amorphous (7631-86-9)	Yes	Yes	Yes	Yes

-----\Chemical Inventory Status - Part 2\-----				
Ingredient	Korea	--Canada--		Phil.
		DSL	NDSL	
Cuprous Iodide (7681-65-4)	Yes	Yes	No	Yes
Sulfur (7704-34-9)	Yes	Yes	No	Yes
Starch (9005-25-8)	Yes	Yes	No	Yes
Silica, Amorphous (7631-86-9)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----				
Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Cuprous Iodide (7681-65-4)	No	No	No	Copper compo
Sulfur (7704-34-9)	No	No	No	No

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S h (9005-25-8)	No	No	No	No
Silica, Amorphous (7631-86-9)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8 (d)
Cuprous Iodide (7681-65-4)	No	No	No
Sulfur (7704-34-9)	No	No	No
Starch (9005-25-8)	No	No	No
Silica, Amorphous (7631-86-9)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
 SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
 Reactivity: No (Mixture / Solid)

Australian Hazchem Code: No information found.

Poison Schedule: S7

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 2 Flammability: 1 Reactivity: 0

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED OR INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. DUST MAY FORM FLAMMABLE OR EXPLOSIVE MIXTURE WITH AIR.

Label Precautions:

Avoid contact with eyes, skin and clothing.

Avoid breathing dust.

Keep container closed.

Use only with adequate ventilation.

Wash thoroughly after handling.

Keep away from heat, sparks and flame.

Avoid dust cloud in presence of an ignition source.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In all cases, get medical attention.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 2, 3, 8, 11, 16.

Disclaimer:

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

Prepared by: Strategic Services Division

Phone Number: (314) 539-1600 (U.S.A.)

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CHEMTREC: 1-800-424-8300

National Response in Canada
CANUTEC: 613-898-6666

Outside U.S. and Canada
Chemtrec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-562-2537) for assistance.

Mercury Spill Clean-up Kit

MSDS Number: Z6015 --- Effective Date: 08/25/00

1. Product Identification

Synonyms: The Mercury Spill Clean-Up Kit contains three different spill-kit products. See appropriate MSDSs for - CINNASORB(tm) Elemental Mercury Absorbent Base (MSDS# Z6058), - CINNASORB(tm) Elemental Mercury Absorbent Activator (MSDS# Z6059), and - RESISORB(R) Mercury Vapor Absorbent (MSDS# Z6140).

CAS No.: Not applicable.

Molecular Weight: Not applicable.

Chemical Formula: Not applicable.

Product Codes: 4439

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Kit contains these chemicals:			
Sulfamic Acid	5329-14-6	*	Yes
Zinc	7440-66-6	*	Yes
Zinc Oxide	1314-13-2	*	Yes
Lead	7439-92-1	*	Yes
Activated Carbon	7440-44-0	*	Yes

N0007869

To a

7553-56-2

*

Yes

See appropriate MSDS for each
component of this kit.

3. Hazards Identification

Emergency Overview

DANGER! CORROSIVE. CAUSES SEVERE IRRITATION OR BURNS TO EVERY AREA OF CONTACT. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED. VAPORS CAUSE SEVERE IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CARDIOVASCULAR, RESPIRATORY AND CENTRAL NERVOUS SYSTEMS. MAY CAUSE LUNG DAMAGE. MAY CAUSE ALLERGIC SKIN OR RESPIRATORY REACTION. MAY FORM COMBUSTIBLE DUST CONCENTRATIONS IN AIR. WATER REACTIVE. MAY AFFECT THE GUM TISSUE, CENTRAL NERVOUS SYSTEM, KIDNEYS, BLOOD AND REPRODUCTIVE SYSTEM (lead component).

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate

Flammability Rating: 1 - Slight

Reactivity Rating: 2 - Moderate

Contact Rating: 3 - Severe (Corrosive)

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER.

Storage Color Code: White (Corrosive)

Potential Health Effects

For health effect information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Inhalation:

Not applicable.

Ingestion:

Not applicable.

Skin Contact:

Not applicable.

Eye Contact:

Not applicable.

Chronic Exposure:

Not applicable.

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Aggravation of Pre-existing Conditions:
Not applicable.

4. First Aid Measures

For first aid information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Inhalation:

Not applicable.

Ingestion:

Not applicable.

Skin Contact:

Not applicable.

Eye Contact:

Not applicable.

5. Fire Fighting Measures

Fire:

For fire fighting information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Explosion:

Not applicable.

Fire Extinguishing Media:

Not applicable.

Special Information:

Not applicable.

6. Accidental Release Measures

Remove all sources of ignition. Use non-sparking tools and equipment. Substance may be pyrophoric and self-ignite. Water reactive. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8 of component MSDSs. Spills: Sweep up in a manner that does not disperse powder in the air and containerize for reclamation or disposal. For spill treatment information regarding the components of this kit, please refer to the corresponding MSDS for each component. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Keep away from moisture and oxidizers. Avoid dust dispersal. Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered in confined spaces. Work procedures for potentially low oxygen areas should be followed. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

For exposure control and personal protection information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Ventilation System:

Not applicable.

Personal Respirators (NIOSH Approved):

Not applicable.

Skin Protection:

Not applicable.

Eye Protection:

Not applicable.

9. Physical and Chemical Properties

For physical and chemical property information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Appearance:

Not applicable.

Odor:

Not applicable.

Solubility:

Not applicable.

Specific Gravity:

Not applicable.

pH:

Not applicable.

% Volatiles by volume @ 21C (70F):

Not applicable.

Boiling Point:

Not applicable.

Melting Point:

Not applicable.

Vapor Density (Air=1):

Not applicable.

Vapor Pressure (mm Hg):

Not applicable.

Evaporation Rate (BuAc=1):

Not applicable.

10. Stability and Reactivity

Stability:

For stability and reactivity information regarding the components of this kit, please refer to the corresponding MSDS for each component.

Hazardous Decomposition Products:

Not applicable.

Hazardous Polymerization:

Not applicable.

Incompatibilities:

Not applicable.

Conditions to Avoid:

Not applicable.

11. Toxicological Information

For toxicological information regarding the components of this kit, please refer to the corresponding MSDS for each component.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Sulfamic Acid (5329-14-6)	No	No	None
Zinc (7440-66-6)	No	No	None
Zinc Oxide (1314-13-2)	No	No	None
Lead (7439-92-1)	No	No	2B
Activated Carbon (7440-44-0)	No	No	None
Iodine (7553-56-2)	No	No	None

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12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Sulfamic Acid (5329-14-6)	Yes	Yes	Yes	Yes
Zinc (7440-66-6)	Yes	Yes	No	Yes
Zinc Oxide (1314-13-2)	Yes	Yes	Yes	Yes
Lead (7439-92-1)	Yes	Yes	Yes	Yes
Activated Carbon (7440-44-0)	Yes	Yes	No	Yes
Iodine (7553-56-2)	Yes	Yes	No	Yes

-----\Chemical Inventory Status - Part 2\-----				
Ingredient	Korea	--Canada--		Phil.
		DSL	NDSL	
Sulfamic Acid (5329-14-6)	Yes	Yes	No	Yes
Zinc (7440-66-6)	Yes	Yes	No	Yes

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Zinc Oxide (1314-13-2)	Yes	Yes	No	Yes
Lead (7439-92-1)	Yes	Yes	No	Yes
Activated Carbon (7440-44-0)	Yes	Yes	No	Yes
Iodine (7553-56-2)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----

Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Sulfamic Acid (5329-14-6)	No	No	No	No
Zinc (7440-66-6)	No	No	Yes	No
Zinc Oxide (1314-13-2)	No	No	No	Zinc compound
Lead (7439-92-1)	No	No	Yes	No
Activated Carbon (7440-44-0)	No	No	No	No
Iodine (7553-56-2)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	CERCLA	-RCRA-	-TSCA-
		261.33	8(d)
Sulfamic Acid (5329-14-6)	No	No	No
Zinc (7440-66-6)	1000	No	No
Zinc Oxide (1314-13-2)	No	No	No
Lead (7439-92-1)	10	No	No
Activated Carbon (7440-44-0)	No	No	No
Iodine (7553-56-2)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: Yes (Mixture / Solid)

WARNING:

THIS PRODUCT CONTAINS CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM.

Australian Hazchem Code: No information found.

Poison Schedule: No information found.

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 1 Reactivity: 1 Other: Water reactive
Label Hazard Warning:

N0007875

Do not breathe dust or vapor.
Store in a tightly closed container.
Do not get in eyes, on skin, or on clothing.
Use only with adequate ventilation.
Wash thoroughly after handling.
Do not contact with water.

If swallowed, get medical attention immediately. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Spill Clean-Up

MSDS Section(s) changed since last revision of document include: 3, 7, 16.

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

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MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865



24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-998-6666

Outside U.S. and Canada
Chemtec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

Mercury Sponge

MSDS Number: Z6040 --- Effective Date: 11/06/97

1. Product Identification

Synonyms: None
CAS No.: Not applicable to mixtures.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: 4486, 4487

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Citric Acid	77-92-9	40 - 60%	Yes
Zinc	7440-66-6	< 10%	Yes
Steel Wool	N/A	40 - 60%	Yes

3. Hazards Identification

Emergency Overview

WARNING! CAUSES SEVERE EYE IRRITATION. CAUSES IRRITATION TO SKIN AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 0 - None
 Flammability Rating: 1 - Slight
 Reactivity Rating: 0 - None
 Contact Rating: 1 - Slight
 Lab Protective Equip: GOGGLES; LAB COAT
 Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:

Causes irritation to the respiratory tract. Symptoms may include coughing, shortness of breath. When heated, the fumes from zinc are highly toxic and may cause fume fever.

Ingestion:

Causes irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea. Extremely large oral dosages may produce gastrointestinal disturbances.

Skin Contact:

Causes irritation to skin. Symptoms include redness, itching, and pain.

Eye Contact:

Highly irritating; may also be abrasive.

Chronic Exposure:

No information found.

Aggravation of Pre-existing Conditions:

No information found.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.

Skin Contact:

Immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Fire Extinguishing Media:

Water spray, dry chemical, alcohol foam, or carbon dioxide.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Note: if this product has been utilized to clean up a mercury spill, handle and dispose of as a hazardous waste containing mercury. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

None established.

Ventilation System:

In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.

Personal Respirators (NIOSH Approved):

For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator.

WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Gray solid.

Odor:

No information found.

Solubility:

Negligible (< 0.1%)

Specific Gravity:

No information found.

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

No information found.

Melting Point:

No information found.

Vapor Density (Air=1):

Not applicable.

Vapor Pressure (mm Hg):

Not applicable.

N0007880

Vaporization Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Oxides of carbon, zinc and iron may form when heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Citric Acid Component:

Metal nitrates (potentially explosive reaction), alkali carbonates and bicarbonates, potassium tartrate. Will corrode copper, zinc, aluminum and their alloys.

Zinc powder can react violently with water, sulfur and halogens. Dangerous or potentially dangerous with strong oxidizing agents, lower molecular weight chlorinated hydrocarbons, strong acids and alkalis.

Steel Wool: Strong oxidizers, water (including humid atmospheres), acids, hydrogen peroxide, nitrogen dioxide. May ignite or explode on contact with acetaldehyde, ammonium peroxodisulfate, chloroformamidinium, chloric acid, ammonium nitrate, halogens, dinitrogen tetroxide, nitryl fluoride, polystyrene, sodium acetylide, potassium dichromate, peroxyformic acid, and nitryl fluoride.

Conditions to Avoid:

Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Mercury Sponge: No LD50/LC50 information found relating to normal routes of occupational exposure.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Citric Acid (77-92-9)	No	No	None
Zinc (7440-66-6)	No	No	None
Steel Wool	No	No	None

12. Ecological Information

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Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Citric Acid (77-92-9)	Yes	Yes	Yes	Yes
Zinc (7440-66-6)	Yes	Yes	No	Yes
Steel Wool	Exempt	No	No	No

-----\Chemical Inventory Status - Part 2\-----				
Ingredient	Korea	--Canada--		Phil.
		DSL	NDSL	
Citric Acid (77-92-9)	Yes	Yes	No	Yes
Zinc (7440-66-6)	Yes	Yes	No	Yes
Steel Wool	No	No	No	No

-----\Federal, State & International Regulations - Part 1\-----				
Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Citric Acid (77-92-9)	No	No	No	No
Zinc (7440-66-6)	No	No	Yes	No

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Steel Wool

No No No No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Citric Acid (77-92-9)	No	No	No
Zinc (7440-66-6)	1000	No	No
Steel Wool	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
 SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
 Reactivity: No (Mixture / Solid)

Australian Hazchem Code: No information found.

Poison Schedule: S7

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 2 Flammability: 1 Reactivity: 0

Label Hazard Warning:

WARNING! CAUSES SEVERE EYE IRRITATION. CAUSES IRRITATION TO SKIN AND RESPIRATORY TRACT.

Label Precautions:

Avoid contact with eyes, skin and clothing.

Avoid breathing dust.

Keep container closed.

Use only with adequate ventilation.

Wash thoroughly after handling.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In all cases, get medical attention.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3, 4, 5, 6, 7, 8, 10, 11, 15, 16.

Disclaimer:

N0007883

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

N0007884

MAYER, BROWN & PLATT

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312-782-0600

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312-701-7711

October 6, 2000

VIA HAND DELIVERY

Rebecca A. Burlingham
Senior Assistant Attorney General
Environmental Bureau
188 W. Randolph St., 20th Floor
Chicago, Illinois 60601

RE: People v. Nicor Inc. - 00 CH 12962 (Cook County)

Dear Ms. Burlingham:

As promised during the Illinois Attorney General task force meetings of October 2 and 4, enclosed is a copy of the Quality Assurance and Quality Control program with attached appendices and the related health and safety plan compiled by The IT Group (Bates numbers N0007597- N0007953) for the Nicor Gas mercury regulator inspection and cleanup program. IT is acting as independent consultant to Nicor Gas.

Sincerely,



John C. Berghoff, Jr.

JCB:jmr
Enclosure

MAYER, BROWN & PLATT

Rebecca A. Burlingham
October 6, 2000

cc: Paul F. Bruckner – DuPage County State's Attorney's Office (w/enclosures)
Terry McDonald – Cook County State's Attorney's Office (w/enclosures)
Dawn Underhill – Will County State's Attorney's Office (w/enclosures)
Bill Ingersoll – Illinois EPA (w/enclosures)
Brad Stimple – United States EPA (w/enclosure)
Thomas Krueger – United States EPA (w/enclosure)
Michael Moomey – Illinois Dept. of Public Health (w/enclosure)
Louise Fabinski – ATSDR (w/enclosure)
Richard Favoritti – Illinois Commerce Commission (w/enclosure)
Charles Fisher – Illinois Commerce Commission (w/enclosures)
Counsel for Co-Defendants (w/o enclosures)



Selective Adsorption Associates, Inc.
534 Gables Court Langhorne, PA 19047 USA
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PRODUCT DATA

MERSORB®

MERCURY ADSORBENT

MERCURY VAPOR REMOVAL FROM:
AIR, HYDROGEN, & OTHER GASES

BENEFITS

- Longer Service Life
- High Hg Removal Efficiency
- Less Blower Horsepower Required
- Clean Operation
- Proven Performance
- Dependable Technical Support

PERFORMANCE FEATURES

- Pellets Minimize Flow Channelling, thus Maximizing Adsorbent Performance
- 50 % Lower Pressure Drop than 4x10 granular
- Hard, Low Dust Pellets
- Many Commercial Installations, Worldwide
- Backed by Extensive Lab & Field Test Data

PRODUCT FEATURES

- FORM: Extruded Pellets of Uniform Diameter, Available in Pellet Diameters of 1.5 mm, 3 mm, or 4 mm.
- IMPREGNATION: Elemental Sulfur Dispersed on High Surface Area Activated Carbon.
- SURFACE AREA of CARBON SUBSTRATE: 1,000 sq. meters per gram (by N₂ BET test method)
- HARDNESS: 97 % Hardness, Minimum (ASTM D 3802)
- PACKED BULK DENSITY: 34 Lbs per Cu. Ft. (550 Kg/Cu. Meter)(ASTM D 2854)
- SULFUR CONTENT: 13 Wt. %, Typical
- MERCURY CAPACITY: ≥ 20 Wt. % Hg Adsorption Capacity is Typical in Dynamic, Gas-Treatment Applications
- MOISTURE CONTENT: 3 Wt. %, Maximum (ASTM D 2867)
- pH: 6-8 (ASTM D 3838)

N0007885

- RECYCLING: Spent, Hg-loaded Adso. Can Be Processed by Mercury Recycling Companies.

APPLICATIONS

MERSORB® mercury adsorbent has proven performance in many commercial applications requiring removal of mercury vapor to extremely low concentrations in air, hydrogen, and other gases. Typically, a gas contact time of 10 seconds is used in designing process systems with MERSORB® adsorbent. MERSORB® mercury adsorbent installations have demonstrated performance for reducing mercury concentrations to < 1 microgram Hg/Nm³ in both dry and water saturated gases, with appropriate gas contact times. Extensive technical data, adsorption design and field technical services are available.

CAUTION: Wet activated carbon removes oxygen from air. Thus, an asphyxiation hazard exists inside enclosed spaces containing activated carbon. Use appropriate safety precautions when entering vessels or other enclosed spaces containing activated carbon.

MERSORB® is a registered trademark of NUCON International, Inc. (NUCON®) for impregnated activated carbons used to remove mercury from gases and liquids. Information presented herein is believed to be accurate and reliable but does not provide any guarantee or warranty by NUCON International, Inc. or by Selective Adsorption Associates, Inc. Nothing herein shall be construed as an invitation to use processes covered by patents without proper arrangements with individuals or companies owning those patents.

Selective Adsorption Associates, Inc. 534 Gables Court Langhorne, PA 19047 USA
Telephone: (215) 702-0323 FAX: (215) 702-0577 Email: saai@selectiveadsorption.com

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<http://www.selectiveadsorption.com>

N0007886

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MSDS**Material Safety Data Sheet**

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response In Canada
CANUTEC: 613-898-6868

Outside U.S. and Canada
Chemtrec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-562-2537) for assistance.

NITRIC ACID, 50-70%

MSDS Number: N3660 --- Effective Date: 07/13/00

1. Product Identification

Synonyms: Aqua Fortis; Azotic Acid; Nitric Acid 50%; Nitric Acid 65%; nitric acid 69-70%

CAS No.: 7697-37-2

Molecular Weight: 63.01

Chemical Formula: HNO₃

Product Codes:

J.T. Baker: 5371, 5555, 5801, 5876, 9597, 9598, 9600, 9601, 9602, 9604, 9606, 9607, 9616, 9617

Mallinckrodt: 1409, 2703, 2704, 6623, H988, H993, H998, V069, V077, V336, V561, V633, V650

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Nitric Acid	7697-37-2	50 - 70%	Yes
Water	7732-18-5	30 - 50%	No

3. Hazards Identification

Emergency Overview

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)

Flammability Rating: 0 - None

Reactivity Rating: 3 - Severe (Oxidizer)

Contact Rating: 4 - Extreme (Corrosive)

Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES

Storage Color Code: Yellow (Reactive)

Potential Health Effects

Nitric acid is extremely hazardous; it is corrosive, reactive, an oxidizer, and a poison.

Inhalation:

Corrosive! Inhalation of vapors can cause breathing difficulties and lead to pneumonia and pulmonary edema, which may be fatal. Other symptoms may include coughing, choking, and irritation of the nose, throat, and respiratory tract.

Ingestion:

Corrosive! Swallowing nitric acid can cause immediate pain and burns of the mouth, throat, esophagus and gastrointestinal tract.

Skin Contact:

Corrosive! Can cause redness, pain, and severe skin burns. Concentrated solutions cause deep ulcers and stain skin a yellow or yellow-brown color.

Eye Contact:

Corrosive! Vapors are irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage.

Chronic Exposure:

Long-term exposure to concentrated vapors may cause erosion of teeth and lung damage. Long-term exposures seldom occur due to the corrosive properties of the acid.

Aggravation of Pre-existing Conditions:

Persons with pre-existing skin disorders, eye disease, or cardiopulmonary diseases may be more susceptible to the effects of this substance.

4. First Aid Measures

Immediate first aid treatment reduces the health effects of this substance.

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

Ingestion:

DO NOT INDUCE VOMITING! Give large quantities of water or milk if available. Never give anything by mouth to an unconscious person. Get medical attention immediately.

Skin Contact:

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Can react with metals to release flammable hydrogen gas.

Explosion:

Reacts explosively with combustible organic or readily oxidizable materials such as: alcohols, turpentine, charcoal, organic refuse, metal powder, hydrogen sulfide, etc. Reacts with most metals to release hydrogen gas which can form explosive mixtures with air.

Fire Extinguishing Media:

Water spray may be used to keep fire exposed containers cool. Do not get water inside container.

Special Information:

Increases the flammability of combustible, organic and readily oxidizable materials. In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

N0007889

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Neutralize with alkaline material (soda ash, lime), then absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number

the US Coast Guard National Response Center is (800) 42 02.

J. T. Baker NEUTRASORB(R) or TEAM(R) 'Low Na+' acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Store in a cool, dry, ventilated storage area with acid resistant floors and good drainage. Protect from physical damage. Keep out of direct sunlight and away from heat, water, and incompatible materials. Do not wash out container and use it for other purposes. When diluting, the acid should always be added slowly to water and in small amounts. Never use hot water and never add water to the acid. Water added to acid can cause uncontrolled boiling and splashing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

-OSHA Permissible Exposure Limit (PEL):

2 ppm (TWA), 4 ppm (STEL)

-ACGIH Threshold Limit Value (TLV):

2 ppm (TWA); 4 ppm (STEL)

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):

If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Nitric acid is an oxidizer and should not come in contact with cartridges and canisters that contain oxidizable materials, such as activated charcoal. Canister-type respirators using sorbents are ineffective.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Colorless to yellowish liquid.

Odor:

Suffocating, acrid.

Solubility:

Infinitely soluble.

Specific Gravity:

1.41

pH:

1.0 (0.1M solution)

% Volatiles by volume @ 21C (70F):

100 (as water and acid)

Boiling Point:

122C (252F)

Melting Point:

-42C (-44F)

Vapor Density (Air=1):

2-3

Vapor Pressure (mm Hg):

48 @ 20C (68F)

Evaporation Rate (BuAc=1):

No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage. Containers may burst when heated.

Hazardous Decomposition Products:

When heated to decomposition, emits toxic nitrogen oxides fumes and hydrogen nitrate. Will react with water or steam to produce heat and toxic and corrosive fumes.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

A dangerously powerful oxidizing agent, concentrated nitric acid is incompatible with most substances, especially strong bases, metallic powders, carbides, hydrogen sulfide, turpentine, and combustible organics.

Conditions to Avoid:

Light and heat.

11. Toxicological Information

Nitric acid: Inhalation rat LC50: 244 ppm (NO2)/30M; Investigated as a mutagen, reproductive effector. Oral (human) LDLo: 430 mg/kg.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Nitric Acid (7697-37-2)	No	No	None
Water (7732-18-5)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

Environmental Toxicity:

No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8

UN/NA: UN2031

Packing Group: II

Information reported for product/size: 150LB

N0007892

International (Water, I.M.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8

UN/NA: UN2031

Packing Group: II

Information reported for product/size: 150LB

International (Air, I.C.A.O.)

Proper Shipping Name: NITRIC ACID (WITH NOT MORE THAN 70% NITRIC ACID)

Hazard Class: 8

UN/NA: UN2031

Packing Group: II

Information reported for product/size: 150LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----
Ingredient TSCA EC Japan Australia

Nitric Acid (7697-37-2) Yes Yes Yes Yes
Water (7732-18-5) Yes Yes Yes Yes

-----\Chemical Inventory Status - Part 2\-----
Ingredient Korea --Canada-- DSL NDSL Phil.

Nitric Acid (7697-37-2) Yes Yes No Yes
Water (7732-18-5) Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----
Ingredient -SARA 302- -SARA 313-
RQ TPQ List Chemical Catg.

Nitric Acid (7697-37-2) 1000 1000 Yes No
Water (7732-18-5) No No No No

-----\Federal, State & International Regulations - Part 2\-----
Ingredient CERCLA -RCRA- -TSCA-
261.33 8(d)

Nitric Acid (7697-37-2) 1000 No No
Water (7732-18-5) No No No

N0007893

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No

SARA 1/312: Acute: Yes Chronic: Yes Fire: Yes Sure: No
Reactivity: No (Mixture / Liquid)

Australian Hazchem Code: 2PE

Poison Schedule: S6

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 0 Reactivity: 0 Other: **Oxidizer**

Label Hazard Warning:

POISON! DANGER! STRONG OXIDIZER. CONTACT WITH OTHER MATERIAL MAY CAUSE FIRE. CORROSIVE. LIQUID AND MIST CAUSE SEVERE BURNS TO ALL BODY TISSUE. MAY BE FATAL IF SWALLOWED OR INHALED. INHALATION MAY CAUSE LUNG AND TOOTH DAMAGE.

Label Precautions:

Do not get in eyes, on skin, or on clothing.

Do not breathe vapor or mist.

Use only with adequate ventilation.

Wash thoroughly after handling.

Keep from contact with clothing and other combustible materials.

Do not store near combustible materials.

Store in a tightly closed container.

Remove and wash contaminated clothing promptly.

Label First Aid:

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases get medical attention immediately.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 1.

Disclaimer:

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

N0007895

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MSDS

Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865



24 Hour Emergency Telephone: 800-859-2151
CHEMTREC: 1-800-424-8300

National Response In Canada
CANUTEC: 613-696-6666

Outside U.S. and Canada
Chemtec: 202-483-7816

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

RESISORB(R) - Mercury Vapor Absorbent

MSDS Number: Z6140 --- Effective Date: 08/25/00

1. Product Identification

Synonyms: Activated Carbon and Iodine

CAS No.: Not applicable to mixtures.

Molecular Weight: Not applicable to mixtures.

Chemical Formula: Not applicable to mixtures.

Product Codes: 4455

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Iodine	7553-56-2	5 - 25%	Yes
Activated Carbon	7440-44-0	75 - 95%	Yes

3. Hazards Identification

N0007896

Emergency Overview

WARNING! HARMFUL IF SWALLOWED OR INHALED. CONTACT AND VAPORS MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. AFFECTS CARDIOVASCULAR, RESPIRATORY AND CENTRAL NERVOUS SYSTEMS. MAY CAUSE ALLERGIC SKIN OR RESPIRATORY REACTION.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate

Flammability Rating: 1 - Slight

Reactivity Rating: 2 - Moderate

Contact Rating: 2 - Moderate

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

Storage Color Code: Orange (General Storage)

Potential Health Effects

Health hazards given below for the iodine component are for the concentrated free iodine. The degree of hazard for reduced concentrations is not currently addressed in the available literature.

Inhalation:

Iodine Component:

Vapors severely irritate and can burn the mucous membranes and respiratory tract. Excessive tears, rhinitis, tightness in the chest, sore throat, headache and delayed pulmonary edema can result. Inhalation of concentrated vapors may be fatal.

Activated Carbon Component:

No adverse effects expected. May cause mild irritation to the respiratory tract.

Ingestion:

Iodine Component:

Can cause severe burns of the mouth, throat and stomach. Causes abdominal pain, diarrhea, fever, vomiting, stupor and shock. Probable lethal dose is 2 to 4 gm of free iodine.

Activated Carbon Component:

No adverse effects expected. May cause mild irritation to the gastrointestinal tract.

Skin Contact:

Iodine Component: Contact may cause blistering burns, irritation, and pain. Vapors may be severely irritating to the skin.

Activated Carbon Component: Not expected to be a health hazard from skin exposure. May cause mild irritation and redness.

Eye Contact:

Iodine Component: Vapors are severely irritating and may cause damage to the eyes. Contact may cause severe burns and permanent eye damage. Activated Carbon Component: No adverse effects expected. May cause mild irritation, possible reddening.

Chronic Exposure:**Iodine Component:**

Chronic exposure to iodine may cause insomnia, conjunctivitis, inflammation of the nasal mucous, bronchitis, tremor, rapid heart beat, diarrhea and weight loss. Allergic sensitization may occur. Chronic iodine overdoses have produced iodism. Headache, fever, sneezing, salivation, and skin rashes may occur.

Activated Carbon Component:

Prolonged inhalation of excessive dust may produce pulmonary disorders.

Aggravation of Pre-existing Conditions:

Iodine Component: Persons with pre-existing skin disorders, eye problems, impaired respiratory function, or disease of the thyroid, lungs, or kidney may be more susceptible to the effects of the substance.

4. First Aid Measures

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.

Skin Contact:

Immediately flush skin with plenty of soap and water. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse. Iodine stains can be removed by immediately washing skin with 5% sodium thiosulfate solution.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source. Activated carbon is difficult to ignite and tends to burn slowly (smolder) without producing smoke or flame. Wet activated carbon depletes oxygen from the air. Materials allowed to smolder for long periods in enclosed spaces, may produce amounts of carbon monoxide which may reach the lower explosive limit for carbon monoxide of 12.5% in air. Contact with strong oxidizers such as ozone or liquid oxygen may cause rapid combustion.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Minimum explosible concentration 0.140 g/l.

Fire Extinguishing Media:

Water spray, dry chemical, alcohol foam, or carbon dioxide.

N0007898

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. Warning! Spent product may have absorbed hazardous materials.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Keep away from moisture and oxidizers. Avoid dust dispersal. Wet activated carbon depletes oxygen from the air and therefore dangerously low levels of oxygen may be encountered in confined spaces. Work procedures for potentially low oxygen areas should be followed. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:**Iodine Component:**

- OSHA Permissible Exposure Limit (PEL):

0.1 ppm Ceiling

- ACGIH Threshold Limit Value (TLV):

0.1 ppm (STEL) ceiling

Activated Carbon Component:

- OSHA Permissible Exposure Limits (PELs):

activated carbon (graphite, synthetic): total particulate = 15 mg/m³ (TWA), respirable fraction = 5 mg/m³ (TWA).

- ACGIH Threshold Limit Values (TLVs):

graphite, all forms except graphite fibers: 2 mg/m³ (TWA).

Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits.

Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual*

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Recommended Practices, most recent edition, for details. Use explosion-proof equipment.

Personal Respirators (NIOSH Approved):

Iodine Component: If the exposure limit is exceeded, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. This substance has unknown warning properties. **Activated Carbon Component:** If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest. A full-face piece dust/mist respirator may be worn up to 50 times the exposure limit, or the maximum use concentration specified by the appropriate regulatory agency, or respirator supplier, whichever is lowest. For emergencies or instances where the exposure levels are not known, use a full-facepiece positive-pressure, air-supplied respirator. **WARNING:** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Eye Protection:

Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:

Black solid

Odor:

Characteristic iodine odor.

Solubility:

Negligible (< 0.1%)

Specific Gravity:

No information found.

pH:

No information found.

% Volatiles by volume @ 21C (70F):

No information found.

Boiling Point:

No information found.

Melting Point:

No information found.

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

N0007900

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:

Burning may produce toxic iodine vapors. Carbon dioxide and carbon monoxide may form when heated to decomposition.

Hazardous Polymerization:

Will not occur.

Incompatibilities:**Iodine Component:**

Ammonia, strong acids, powdered metals, alkali metals, acetaldehyde, acetylene, ammonium hydroxide, and strong reducing agents.

Activated Carbon Component:

Strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in rapid combustion. Avoid contact with strong acids.

Conditions to Avoid:

Heat, flame, ignition sources, moisture, and incompatibles.

11. Toxicological Information

Iodine Component:

Oral rat LD50: 14 gm/kg; Human LDLo: 28 mg/kg; Investigated as a reproductive effector.

Activated Carbon Component:

Investigated as a reproductive effector.

-----\Cancer Lists\-----

Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Iodine (7553-56-2)	No	No	None
Activated Carbon (7440-44-0)	No	No	None

12. Ecological Information

Environmental Fate:

N0007901

o information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste facility. Although not a listed RCRA hazardous waste, this material may exhibit one or more characteristics of a hazardous waste and require appropriate analysis to determine specific disposal requirements. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\-----				
Ingredient	TSCA	EC	Japan	Australia
Iodine (7553-56-2)	Yes	Yes	No	Yes
Activated Carbon (7440-44-0)	Yes	Yes	No	Yes

-----\Chemical Inventory Status - Part 2\-----				
Ingredient	Korea	DSL	NDSL	Phil.
Iodine (7553-56-2)	Yes	Yes	No	Yes
Activated Carbon (7440-44-0)	Yes	Yes	No	Yes

-----\Federal, State & International Regulations - Part 1\-----				
Ingredient	-SARA 302-		-----SARA 313-----	
	RQ	TPQ	List	Chemical Catg.
Iodine (7553-56-2)	No	No	No	No
Activated Carbon (7440-44-0)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----	
-RCRA-	-TSCA-

N0007902

1 edient	CERCLA	61.33	8(d)
-----	-----	-----	-----
Iodine (7553-56-2)	No	No	No
Activated Carbon (7440-44-0)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: No Pressure: No
Reactivity: Yes (Mixture / Solid)

Australian Hazchem Code: No information found.

Poison Schedule: S6

WHMIS:

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 3 Flammability: 1 Reactivity: 0

Label Hazard Warning:

WARNING! HARMFUL IF SWALLOWED OR INHALED. CONTACT AND VAPORS MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT. AFFECTS CARDIOVASCULAR, RESPIRATORY AND CENTRAL NERVOUS SYSTEMS. MAY CAUSE ALLERGIC SKIN OR RESPIRATORY REACTION.

Label Precautions:

Avoid breathing dust or vapors.
Store in a tightly closed container.
Use only with adequate ventilation.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of skin contact, immediately flush skin with plenty of soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.

Product Use:

Spill Clean-Up

Revision Information:

MSDS Section(s) changed since last revision of document include: 3, 7, 10, 15, 16.

Disclaimer:

N0007903

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Prepared by: Strategic Services Division
Phone Number: (314) 539-1600 (U.S.A.)

N0007904

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MSDS

Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

MALLINCKRODT



24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response In Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtec: 202-483-7818

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SULFUR

MSDS Number: S8138 --- Effective Date: 06/04/98

1. Product Identification

Synonyms: Colloidal sulfur; flowers of sulfur; precipitated sulfur; sublimed sulfur; brimstone

CAS No.: 7704-34-9

Molecular Weight: 256.53

Chemical Formula: S8

Product Codes:

J.T. Baker: 4084, 4088

Mallinckrodt: 8400, 8420, 8422

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sulfur	7704-34-9	100%	Yes

N0007905

3. Hazards Identification

Emergency Overview

WARNING! FLAMMABLE SOLID. DUST MAY FORM FLAMMABLE OR EXPLOSIVE MIXTURE WITH AIR. MAY BE HARMFUL IF SWALLOWED OR INHALED. CAUSES EYE IRRITATION. MAY CAUSE IRRITATION TO SKIN AND RESPIRATORY TRACT.

J.T. Baker SAF-T-DATA^(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight

Flammability Rating: 3 - Severe (Flammable)

Reactivity Rating: 0 - None

Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:

Nuisance dust. May cause coughing, sneezing or labored breathing if large amounts are inhaled.

Ingestion:

Considered essentially non-toxic by ingestion. Ingestion of very large amounts may cause sore throat, nausea, headache, and possibly unconsciousness in severe cases. May be converted into hydrogen sulfide in the intestine.

Skin Contact:

May cause irritation.

Eye Contact:

Irritant to human eyes at 6-8 ppm. Redness and pain may be observed.

Chronic Exposure:

Prolonged overexposure to sulfur dust can produce possible skin sensitization and permanent eye damage (clouding of the lens and chronic irritation). Prolonged inhalation can cause irritation of mucous membranes.

Aggravation of Pre-existing Conditions:

Sensitive individuals can experience skin irritation from repeated exposure to sulfur dust. Allergic responses can occur.

4. First Aid Measures

Inhalation:

Remove to fresh air. Get medical attention for any breathing difficulty.

N0007906

Ingestion:

Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.

Skin Contact:

Wash exposed area with soap and water. Get medical advice if irritation develops.

Eye Contact:

Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:

Flash point: 207C (405F) OC

Autoignition temperature: 232C (450F)

Slight fire hazard when exposed to heat or flame.

Explosion:

Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Explosive limits, dust in air, gm/cu meter: Lower - 35, Upper - 1400. Hazardous in contact with oxidizing materials; forms explosive mixtures.

Fire Extinguishing Media:

Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Solid streams of water should not be used because of possibility of dispersing dust clouds of sulfur in air.

Special Information:

In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container.

7. Handling and Storage

Keep in a tightly closed container. Store in a cool, dry, corrosion-proof, ventilated area away from moisture, sources of heat or ignition, combustibles and oxidizers. Protect against physical damage. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process

capable of generating dust and/or static electricity. Empty only into inert or non-flammable atmosphere. Emptying contents into a non-inert atmosphere where flammable vapors may be present could cause a flash fire or explosion due to electrostatic discharge.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:

None established.

Ventilation System:

In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.

Personal Respirators (NIOSH Approved):

For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator.

WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

Other Control Measures:

Comments: Remove any worker from exposure to sulfur who shows allergic reactions; such individual should not be assigned further work where exposed to sulfur without a physician's approval.

9. Physical and Chemical Properties

Appearance:

Fine yellow powder.

Odor:

Faint odor.

Solubility:

Insoluble in water.

Specific Gravity:

2.07 at 20C (68F)

pH:

No information found.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

445C (833F)

Melting Point:

N0007908

.5C (239F)
Vapor Density (Air=1):
8.9
Vapor Pressure (mm Hg):
10 @ 246C (475F)
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage. Transition temperature is about 95C (203F) (slow conversion) between alpha and beta crystalline forms.

Hazardous Decomposition Products:

Burning may produce sulfur oxides.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Chlorates, nitrates and other oxidizing agents. Halogens, carbides, zinc, tin, alkali metals, phosphorus, ammonia, ammonium nitrate, charcoal and many other substances.

Conditions to Avoid:

Heat, flame, ignition sources, dusting and incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure. Irritation: eye human: 8 ppm.

-----\Cancer Lists\-----			
Ingredient	---NTP Carcinogen---		IARC Category
	Known	Anticipated	
Sulfur (7704-34-9)	No	No	None

12. Ecological Information

Environmental Fate:

No information found.

N0007909

Environmental Toxicity:

This material is not expected to be toxic to aquatic life. The LC50/96-hour values for fish are over 100 mg/l.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: SULFUR

Hazard Class: 9

UN/NA: NA1350

Packing Group: III

Information reported for product/size: 100LB

International (Water, I.M.O.)

Proper Shipping Name: SULPHUR

Hazard Class: 4.1

UN/NA: UN1350

Packing Group: III

Information reported for product/size: 100LB

15. Regulatory Information

-----\Chemical Inventory Status - Part 1\----- Ingredient	TSCA	EC	Japan	Australia
Sulfur (7704-34-9)	Yes	Yes	No	Yes

-----\Chemical Inventory Status - Part 2\----- Ingredient	Korea	---Canada--- DSL	NDSL	Phil.

N0007910

Sulfur (7704-34-9)

Yes Yes No Yes

-----\Federal, State & International Regulations - Part 1\-----

Ingredient	-SARA 302- RQ	TPQ	-SARA 313- List	Chemical Catg.
Sulfur (7704-34-9)	No	No	No	No

-----\Federal, State & International Regulations - Part 2\-----

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sulfur (7704-34-9)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: Yes Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: 2[Z]**Poison Schedule:** No information found.**WHMIS:**

This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 2 Flammability: 1 Reactivity: 0**Label Hazard Warning:**

WARNING! FLAMMABLE SOLID. DUST MAY FORM FLAMMABLE OR EXPLOSIVE MIXTURE WITH AIR. MAY BE HARMFUL IF SWALLOWED OR INHALED. CAUSES EYE IRRITATION. MAY CAUSE IRRITATION TO SKIN AND RESPIRATORY TRACT.

Label Precautions:

Keep away from heat, sparks and flame.

Avoid breathing dust.

Keep container closed.

Use with adequate ventilation.

Avoid dust cloud in presence of an ignition source.

Avoid contact with eyes, skin and clothing.

Wash thoroughly after handling.

Label First Aid:

If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an

N0007911

unconscious person. In case of eye contact, immediately flush with plenty of water for at least 15 minutes. If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In all cases call a physician.

Product Use:

Laboratory Reagent.

Revision Information:

MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:

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Prepared by: Strategic Services Division

Phone Number: (314) 539-1600 (U.S.A.)

N0007912

APPENDIX F
ANALYTICAL METHODS

N0007913

MERCURY

6009

Hg

MW: 200.59

CAS: 7439-97-6

RTECS: OV4550000

METHOD: 6009, Issue 2

EVALUATION: PARTIAL

Issue 1: 15 May 1989

Issue 2: 15 August 1994

OSHA : C 0.1 mg/m³ (skin)
NIOSH: 0.05 mg/m³ (skin)
ACGIH: 0.025 mg/m³ (skin)

PROPERTIES: liquid; d 13.55 g/mL @ 20 °C; BP 356 °C;
HP -39 °C; VP 0.16 Pa (0.0012 mm Hg;
13.2 mg/m³) @ 20 °C; Vapor Density
(air=1) 7.0

SYNONYMS: quicksilver

SAMPLING		MEASUREMENT	
SAMPLER:	SOLID SORBENT TUBE (Hopcalite in single section, 200 mg)	TECHNIQUE:	ATOMIC ABSORPTION, COLD VAPOR
FLOW RATE:	0.15 to 0.25 L/min	ANALYTE:	elemental mercury
VOL-MIN:	2 L @ 0.5 mg/m ³	DESORPTION:	conc. HNO ₃ /HCl @ 25 °C, dilute to 50 mL
-MAX:	100 L	WAVELENGTH:	253.7 nm
SHIPMENT:	routine	CALIBRATION:	standard solutions of Hg ²⁺ in 1% HNO ₃
SAMPLE STABILITY:	30 days @ 25 °C [1]	RANGE:	0.1 to 1.2 µg per sample
FIELD BLANKS:	2 to 10 field blanks per set	ESTIMATED LOD:	0.03 µg per sample
MEDIA BLANKS:	at least 3 per set	PRECISION (\bar{S}_r):	0.042 @ 0.9 to 3 µg per sample [4]
ACCURACY			
RANGE STUDIED:	0.002 to 0.8 mg/m ³ [2] (10-L samples)		
BIAS:	not significant		
OVERALL PRECISION (\bar{S}_r):	not determined		
ACCURACY:	not determined		

APPLICABILITY: The working range is 0.01 to 0.5 mg/m³ for a 10-L air sample. The sorbent material irreversibly collects elemental mercury. A prefilter can be used to exclude particulate mercury species from the sample. The prefilter can be analyzed by similar methodology. The method has been used in numerous field surveys [3].

INTERFERENCES: Inorganic and organic mercury compounds may cause a positive interference. Oxidizing gases, including chlorine, do not interfere.

OTHER METHODS: This replaces method 6000 and its predecessors, which required a specialized desorption apparatus [4,5,6]. This method is based on the method of Rathje and Marcero [7] and is similar to the OSHA method ID 145H [2].

REAGENTS:

1. Water, organics-free, deionized.
2. Hydrochloric acid (HCl), conc.
3. Nitric acid (HNO₃), conc.
4. Mercuric oxide, reagent grade, dry.
5. Calibration stock solution, Hg²⁺, 1000 µg/mL. Commercially available or dissolve 1.0798 g of dry mercuric oxide (HgO) in 50 mL of 1:1 hydrochloric acid, then dilute to 1 L with deionized water.
6. Intermediate mercury standard, 1 µg/mL. Place 0.1 mL 1000 µg/mL stock into a 100 mL volumetric containing 10 mL deionized water and 1 mL hydrochloric acid. Dilute to volume with deionized water. Prepare fresh daily.
7. Stannous chloride, reagent grade, 10% in 1:1 HCl. Dissolve 20 g stannous chloride in 100 mL conc. HCl. Slowly add this solution to 100 mL deionized water and mix well. Prepare fresh daily.
8. Nitric acid, 1% (w/v). Dilute 14 mL conc. HNO₃ to 1 L with deionized water.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6-mm OD, 4-mm ID, flame sealed ends with plastic caps, containing one section of 200 mg Hopcalite held in place by glass wool plugs (SKC, Inc., Cat. #226-17-1A, or equivalent).
NOTE: A 37-mm, cellulose ester membrane filter in a cassette preceding the sorbent may be used if particulate mercury is to be determined separately.
2. Personal sampling pump, 0.15 to 0.25 L/min, with flexible connecting tubing.
3. Atomic absorption spectrophotometer with cold vapor generation system (see Appendix) or cold vapor mercury analysis system.*
4. Strip chart recorder, or integrator.
5. Flasks, volumetric, 50-mL, and 100-mL.
6. Pipet, 5-mL, 20-mL, others as needed.
7. Micropipet, 10- to 1000-µL.
8. Bottles, biological oxygen demand (BOD), 300-mL.

* See SPECIAL PRECAUTIONS

SPECIAL PRECAUTIONS: Mercury is readily absorbed by inhalation and contact with the skin. Operate the mercury system in a hood, or bubble vented mercury through a mercury scrubber.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break ends of sampler immediately prior to sampling. Attach sampler to pump with flexible tubing.
3. Sample at an accurately known rate of 0.15 to 0.25 L/min for a total sample size between 2 and 100 L.
NOTE: Include a minimum of three unopened sampling tubes from the same lot as the samples for use as media blanks.
4. Cap sampler and pack securely for shipment.

SAMPLE PREPARATION:

5. Place the Hopcalite sorbent and the front glass wool plug from each sampler in separate 50-mL volumetric flasks.
6. Add 2.5 mL conc. HNO₃ followed by 2.5 mL conc. HCl.
NOTE: The mercury must be in the oxidized state to avoid loss. For this reason, the nitric acid must be added first.
7. Allow the sample to stand for 1 h or until the black Hopcalite sorbent is dissolved. The solution will turn dark brown and may contain undissolved material.
8. Carefully dilute to 50 mL with deionized water. (Final solution is blue to blue-green).
9. Using a volumetric pipet, transfer 20 mL of the sample to a BOD bottle containing 80 mL of deionized water. If the amount of mercury in the sample is expected to exceed the standards, a smaller aliquot may be taken, and the volume of acid adjusted accordingly. The final volume in

the BOD bottle must be 100 mL. To prevent possible loss of mercury during transfer, place the pipet tip below the surface of the liquid in the BOD bottle.

CALIBRATION AND QUALITY CONTROL:

10. Prepare a minimum of two series (six levels each) of working standards covering the range 0.01 to 0.5 µg Hg per aliquot by adding known amounts of the intermediate standard to BOD bottles containing enough 1% nitric acid to bring the final volume to 100 mL.
11. Analyze the working standards together with the samples and blanks (steps 13 through 16). Analyze full set of standards at the beginning of the run, and a second set at the end of the run. Additional standards may be run intermediately during the analysis to confirm instrument response.
12. Prepare calibration graph (peak height vs. solution concentration, µg/sample).

MEASUREMENT:

13. Zero the spectrophotometer by removing the bubbler from the BOD bottle, allowing the baseline on the recorder to stabilize.
14. Place the bubbler in a BOD bottle containing 0.5 µg mercury in 100 mL 1% nitric acid. Adjust the spectrophotometer so that it will give a 75% to full-scale deflection of the recorder.
15. Vent the mercury vapor from the system.
16. Analyze standards, samples and blanks (including media blanks).
 - a. Remove the bubbler from the BOD bottle.
 - b. Rinse the bubbler with deionized water.
 - c. Allow the recorder tracing to establish a stable baseline.
 - d. Remove the stopper from the BOD bottle containing the next sample to be analyzed. Gently swirl the BOD bottle.
 - e. Quickly add 5 mL 10% stannous chloride solution.
 - f. Quickly place the bubbler into the BOD bottle.
 - g. Allow the spectrophotometer to attain maximum absorbance.
 - h. Vent the mercury vapor from the system.
 - i. Place the bubbler into an empty BOD bottle. Continue venting the mercury until a stable baseline is obtained.
 - j. Close the mercury vent.

CALCULATIONS:

17. Calculate the amount of mercury in the sample aliquot (W, µg) from the calibration graph.
18. Calculate the concentration C (mg/m³), of mercury in the air volume sampled, V (L):

$$C = \frac{W \cdot \frac{V_s}{V_a} - B}{V}$$

Where: V_s = original sample volume (step 8; normally 50 mL)
 V_a = aliquot volume (step 9; normally 20 mL)
 B = average amount of mercury present in the media blanks

EVALUATION OF METHOD:

Rathje and Marcero originally used Hopcalite (MSA, Inc.) as the sorbent material [7]. Later, Hopcalite was shown superior to other methods for the determination of mercury vapor [8]. Atmospheres of mercury vapor for the study were dynamically generated in the range 0.05 to 0.2 mg/m³ and an adsorbent tube loading of 1 to 7 µg was used. The Hydrar material sometimes used is similar to Hopcalite. No significant difference in the laboratory analysis of mercury collected on the two sorbent materials was observed [9]. OSHA also validated a method for mercury using Hydrar [2]. An average 99% recovery, with $\bar{S}_r = 0.042$, was seen for 18 samples with known amounts (0.9 to 3 µg) of mercury added (as Hg(NO₃)₂) [10]. No change in recovery was seen for samples stored up to 3 weeks at room temperature or up to 3 months at -15 °C; longer storage times were not investigated [10].

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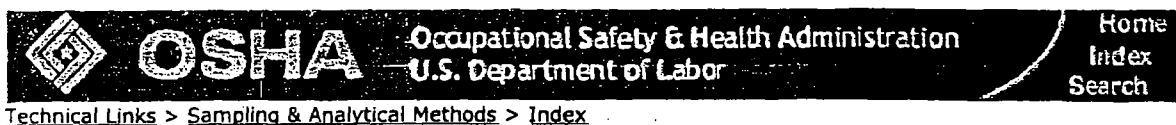
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METHOD WRITTEN BY:

Keith R. Nicholson and Michael R. Steele, DataChem Laboratories, Inc., Salt Lake City, Utah, under NIOSH contract No. 200-87-2533.

APPENDIX: COLD VAPOR MERCURY ANALYSIS SYSTEM

1. The valve should direct the vented vapors to a hood or to a mercury scrubber system.
2. When the valve is opened to "Vent" the peristaltic pump should draw room air. Place a Hopcalite tube in the air intake to eliminate any mercury that may be present.
3. Adjust the peristaltic pump to a flow that will create a steady stream of bubbles in the BOD bottle, but not so great that solution droplets enter the tubing to the quartz cell.
4. If water vapor condenses in the quartz cell, heat the cell slightly above room temperature by wrapping it with a heating coil and attaching a variable transformer.
5. The bubbler consists of a glass tube with a bulb at the bottom, slightly above the bottom of the BOD bottle. The bulb contains several perforations to allow air to escape into the solution (in a stream of small bubbles). A second tube is provided to allow the exit of the vapor. The open end of the second tube is well above the surface of the liquid in the bottle. The two tubes are fixed into a stoppering device (preferably ground glass) which fits into the top of the bottle. A coarse glass frit can be used in place of the bulb on the first tube. However, it is more difficult to prevent contamination when a frit is used.
6. Replace the flexible tubing (Tygon or equivalent) used to connect the bubbler, cell, and pump periodically to prevent contamination from adsorbed mercury.



MERCURY VAPOR IN WORKPLACE ATMOSPHERES

Method Number:	ID-140
Matrix:	Air
OSHA Permissible Exposure Limits Mercury Vapor (Final Rule Limit):	0.05 mg/m ³ (TWA)
Mercury (Transitional Limit):	0.1 mg/m ³ as total mercury (TWA)
Collection Device:	A passive or an active sampling device are available. Both devices use Hydrar [®] or hopcalite as the solid sorbent.
Recommended Sampling Rate Passive Dosimeter:	0.020 L/min (@ 20 °C and 101 kPa)
Active Sampler:	0.20 L/min
Recommended Air Volume Range Passive Dosimeter:	9.6 L
Active Sampler:	3 to 100 L
Analytical Procedure:	The sorbent is digested using nitric acid and hydrochloric acid. The mercury in the sample is reduced to elemental mercury using stannous chloride and analyzed using a cold vapor-atomic absorption spectrophotometer.
Detection Limit	
Qualitative Passive Dosimeter:	0.002 mg/m ³ for a 240-min (4.8 L) sample
Active Sampler:	0.00067 mg/m ³ for a 75-min (15 L) sample
Quantitative Passive Dosimeter:	0.004 mg/m ³ for a 240-min (4.8 L) sample
Active Sampler:	0.0013 mg/m ³ for a 75-min (15 L) sample
Precision and Accuracy Passive Dosimeter Validation Range:	0.061 to 0.20 mg/m ³
CV _T (pooled)	0.039

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Bias	+0.008
Overall Error	±8.6%
Method Classification:	Validated Method
Date (Date Revised):	1987 (June, 1991)

Commercial manufacturers and products mentioned in this method are for descriptive use only and do not constitute endorsements by USDOL-OSHA. Similar products from other sources can be substituted.

Division of Physical Measurements and Inorganic Analyses
OSHA Technical Center
Salt Lake City, Utah

1. Introduction

This method describes the collection of airborne elemental mercury in a passive dosimeter or active sampling device and subsequent analysis using a cold vapor-atomic absorption spectrophotometer (CV-AAS).

1.1. Principle

The mercury dosimeter samples the workplace atmosphere by controlled diffusion into the badge while the active sampler uses a calibrated sampling pump. The mercury vapor entering either passive or active device is collected on a solid sorbent (Hydrar[®] or hopcalite) which has an irreversible affinity for mercury (8.1., 8.2.). After sample collection the sorbent is initially dissolved with concentrated nitric acid and then hydrochloric acid. Stannous chloride is added to an aliquot of the sample to generate mercury vapor. This vapor is then driven into an absorption cell of a flameless atomic absorption spectrophotometer for analysis.

1.2. History

Previously, mercury samples were collected on iodine-impregnated charcoal contained in glass tubes. The treated charcoal was analyzed for mercury by placing it in a tantalum sampling boat and then heating to drive the mercury vapor into the beam of an atomic absorption spectrophotometer (8.3.). The amount of mercury was determined by absorbance at 253.7 nm. The detection limit was approximately 0.1 µg. Drawbacks with this method were:

- a. The mercury vapor and hence the entire sample was immediately lost into the surrounding atmosphere

N0007920

- b. The method was imprecise at lower sample loadings (8.4.)
- c. The analytical technique was somewhat tedious

Hopcalite solid sorbent (8.5.) was substituted in place of the iodine-impregnated charcoal for mercury vapor sampling. Previously, hopcalite had been used in respirator cartridges for carbon monoxide and consisted of oxides of copper, manganese, cobalt, and silver (8.6.). Analysis of recent batches of hopcalite used for mercury collection indicate the composition was mainly oxides of manganese and copper.

Hydrar[®] has been used as a substitute for collecting mercury vapor and is very similar in composition to hopcalite. A ceramic material, insoluble in nitric and hydrochloric acid, is present in the Hydrar[®] but not in the hopcalite.

1.3. Advantages and Disadvantages

1.3.1. These sampling and analytical techniques have adequate sensitivity for measuring workplace atmospheric concentrations of elemental mercury.

1.3.2. The passive dosimeter used for collection of mercury vapor is small, lightweight, and requires no sampling pumps. Also, the dosimeter housing is reusable; therefore, cost per measurement is kept to a minimum.

1.3.3. The collected mercury sample is stable for at least 30 days.

1.3.4. Sample preparation for analysis involves simple procedures.

1.3.5. Either sampling device can be analyzed in any laboratory equipped with a CV-AAS.

1.3.6. A disadvantage with the passive dosimeter is particulate compounds cannot be collected with the device. A separate sampling pump and collection media should be used for particulate collection.

1.3.7. Another disadvantage with the dosimeter is sample rate dependence on face velocity. The dosimeter should not be used in areas where the air velocity is greater than 229 m/min (750 ft/min) since erratic increases in sampling rate may occur.

1.3.8. A disadvantage with the active device is the dependence on a calibrated pump to take the sample.

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1.4. Toxic Effects (This section is for information only and should not be taken as a basis for OSHA policy.)

Exposure to elemental mercury vapor can occur via the respiratory tract and skin. Possible symptoms from an acute exposure include severe nausea, vomiting, abdominal pain, bloody diarrhea, kidney damage, and death. These symptoms usually present themselves within 10 days of exposure. Potential symptoms from a chronic exposure include inflammation of the mouth and gums, excessive salivation, loosening of the teeth, kidney damage, muscle tremors, jerky gait, spasms of the extremities, personality changes, depression, irritability, and

nervousness (8.7., 8.8.).

1.5. Workplace Exposure

Occupations with potential exposure to mercury and its compounds are listed (8.8.):

amalgam makers	fur processors
bactericide makers	gold extractors
barometer makers	histology technicians
battery makers, mercury	ink makers
boiler makers	insecticide makers
bronzers	investment casting workers
calibration instrument makers	jewelers
cap loaders, percussion	laboratory workers, chemical
carbon brush makers	lampmakers, fluorescent
caustic soda makers	manometer makers
ceramic workers	mercury workers
chlorine makers	miners, mercury
dental amalgam makers	neon light makers
dentists	paint makers
direct current meter workers	paper makers
disinfectant makers	percussion cap makers
disinfectors	pesticide workers
drug makers	photographers
dye makers	pressure gage makers
electric apparatus makers	refiners, mercury
electroplaters	seed handlers
embalmers	silver extractors
explosive makers	switch makers, mercury
farmers	tannery workers
fingerprint detectors	taxidermists
fireworks makers	textile printers
fungicide makers	thermometer makers
fur preservers	wood preservative workers

1.6. Properties (8.7., 8.8.)

Elemental mercury (CAS No. 7439-97-6) is a silver-white, heavy, mobile, liquid metal at room temperature. Some physical properties and data for mercury are:

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Atomic Number	80
Atomic Symbol	Hg
Atomic Weight	200.61
Freezing Point	-38.87 °C
Boiling Point	356.90 °C
Density	13.546 g/mL (20 °C)
Synonyms	Quicksilver, Hydrargyrum

The high vapor pressure of mercury at normal temperatures combined with the potential toxicity makes good control measures necessary to avoid exposure. Also, the concentration of mercury vapor in the air rapidly increases as the temperature increases. To illustrate, listed below are vapor pressures of mercury, and mercury concentrations of air after saturation with mercury vapor at different temperatures:

Vapor Pressure-Saturation Concentration of Mercury at Various Temperatures

Temperature		Vapor Pressure	Mercury Concentration
°C	°F	(torr)	(µg/m³)
0	32.0	0.000185	2,180
10	50.0	0.000490	5,880
20	68.0	0.001201	13,200
24	75.2	0.001691	18,300
28	82.4	0.002359	25,200
30	86.0	0.002777	29,500
32	89.6	0.003261	34,400
36	96.8	0.004471	46,600
40	104.0	0.006079	62,600

2. Range

2.1. The qualitative and quantitative detection limits for the analytical procedure are 0.01 µg and 0.02 µg mercury, respectively (8.9.).

2.2. Working Range

The range of the analytical procedure has been determined to be 0.1 to 2 µg mercury. Using the analytical conditions specified, a nonlinear response was noted above 2 µg.

3. Method Performance

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3.1. The SKC Hydrar[®] gas monitoring dosimeter badge for mercury (SKC Inc., Eighty Four, PA) was evaluated at 80% RH and 25 °C over the range of 0.061 to 0.203 mg/m³ using a dynamic generation system (8.2.). The pooled coefficient of

variation (CV_7) for badge samples taken in this concentration range was 0.039. The average recovery was 100.8% and the overall error was $\pm 8.6\%$.

In a separate study, active samplers were spiked with mercury in the range of 1 to 2.5 μg . The mean recovery of these 125 quality control samples was 96.9% with a CV_1 of 0.106 (8.10.).

3.2. In storage stability studies, the mean recoveries of Hydrar[®] samples analyzed 5, 14, and 30 days after collection were within $\pm 10\%$ of the known generated concentration (8.2.).

3.3. The Hydrar[®] active sampling device was compared using linear regression statistics to the dosimeter in a field study (8.11.). The dosimeter results agreed well with the active sampler and are summarized below (Note: A correlation coefficient and slope = 1 would indicate ideal agreement):

Number of paired samples	(N) = 26
Concentration Range	= 0.01 to 0.7 mg/m^3
Correlation coefficient	(r) = 0.985
Intercept	(a) = 0.017
Slope	(b) = 0.960
Standard deviation of the slope	(Sb) = 0.038

4. Interferences

4.1. Sampling:

Particulate mercury compounds are a positive interference; however, the badge does not sample particulates and the glass wool of the active sampler prevents particulate from entering the sorbent. Chlorine in the sampled air does not interfere when using Hydrar[®] or hopcalite sorbent. The chlorine does react with available mercury vapor in the air to presumably form mercuric chloride (8.12.). Workplaces containing both chlorine and mercury should be sampled for both mercury vapor and particulate.

4.2. Analysis:

Organic-free deionized water should be used during sample and standard preparation. Any compound with the same absorbance wavelength as mercury (253.7 nm) can be a positive interference. Some volatile organic compounds (i.e. benzene, toluene, acetone, carbon tetrachloride) absorb at this wavelength and are considered analytical interferences. They occur as contaminants in the reagents used during sample preparation. These compounds are not expected to be retained on Hydrar[®] or hopcalite during sample collection. Analytical interferences are rendered insignificant by using organic-free deionized water and at least reagent grade chemicals or by blank subtraction.

Increasing the concentration of nitric acid in the samples or standards appears to produce an elevated background signal. The nitric acid concentration in the samples and standards should not be greater than 10%.

5. Sampling

N0007924

[Note: A prefilter assembly, consisting of a mixed-cellulose ester filter in a polystyrene cassette, can be used with the active samplers. Although a significant loss of mercury vapor, presumably due to the prefilter assembly, has been noted when using this type of sampling train (8.12.), these results were not duplicated in a series of recent experiments (8.13.).]

5.1. Equipment

Either tubes or dosimeters can be used to collect mercury vapor. The dosimeter should not be used when:

1. The air velocity of the sampling site is greater than 229 m/min (750 ft/min)
2. The operation being sampled is characterized by extremely poor hygienic practices and splashing of mercury on the badge may occur
3. Determination of compliance to the Transitional Permissible Exposure Limit (PEL) to total mercury is necessary and mercury particulate appears to be present in the workplace atmosphere

The tube can be used to determine compliance with the Transitional PEL of 0.1 mg/m³ (TWA) as total mercury (vapor + particulate). The badge can only collect mercury vapor. For Ceiling exposures to particulate mercury, or for wipe and bulk sampling and analysis consult reference 8.14. for further information.

5.1.1. PASSIVE DOSIMETER:

Gas monitoring dosimeter badge and pouch containing a Hydrar[®] capsule [badge - cat. no. 520-03, pouch - cat. no. 520-02 (SKC Inc., Eighty Four, PA)]. The capsule contains 800 mg of sorbent.

5.1.2. ACTIVE SAMPLER:

Hydrar[®] or hopcalite sampling tubes (cat. no. 226-17-1 or 226-17-1A, SKC, Inc., Eighty Four, PA). These are 6-mm o.d. x 70-mm long glass tubes which contain 200 mg of sorbent.

Note: Before use, the active sampling tubes must be examined for movement of the the solid sorbent into the glass wool. See Section 5.3.1. for further details.

5.1.3. Sampling pumps capable of sampling at 0.2 liters per minute (L/min).

5.1.4. Assorted flexible tubing.

5.1.5. Stopwatch and bubble tube or meter for pump calibration.

5.2. Sampling Procedure - PASSIVE DOSIMETER

N0007925

5.2.1. Assemble the components of the mercury monitoring badge according to manufacturer instructions (8.1.).

Note: A foam insert must be placed in the Model 520-03 dosimeter to hold the capsule in place (8.13.).

5.2.2. Record the sampling start time, sampling site temperature, and atmospheric pressure. Remove the protective cap and then place the dosimeter in the breathing zone of the employee. The suggested sampling time for the dosimeter is 8 h.

5.2.3. Immediately after sampling, carefully remove the sorbent capsule from the dosimeter and place it in the sorbent pouch. Fold the pouch top twice and press it flat to seal the capsule inside the pouch. Record the sampling stop time, final temperature, and atmospheric pressure. Calculate and record the total sampling time, average temperature, and pressure.

5.3. Sampling Procedure - ACTIVE SAMPLER

5.3.1. Calibrate each personal sampling pump with an active sampler in-line using a flow rate of about 0.2 L/min.

Note: A prefilter assembly consisting of a mixed-cellulose ester filter, polystyrene cassette, and a minimum amount of Tygon tubing can be used if:

- a. particulate mercury compounds may present a problem during sampling or
- b. the hopcalite or Hydrar[®] contained in the active sampling tube has migrated to the glass wool plug.

Before use, the active sampling tubes must be examined for movement of the solid sorbent into the glass wool. Certain lots of Hydrar[®] or hopcalite have been noted as being very friable or having a sorbent particle-size range small enough as to allow migration. This movement can easily be noted - the glass wool in the sampling tube appears somewhat discolored (darkened) from the small sorbent particles. If sorbent migration has occurred, a prefilter assembly is recommended. The recommended sampling flow rate is also 0.2 L/min with the prefilter-sampling tube-pump assembly.

5.3.2. Connect a sampling tube (or sampling assembly) to a calibrated pump using flexible tubing. If a prefilter is used, connect it to the sampling tube with a minimum amount of Tygon tubing. Connect the other end of the sampling tube to the pump. Place the sampling tube (or assembly) in the breathing zone and the pump in an appropriate position on the employee.

5.3.3. Use an air volume in the range of 3 to 100 L to collect the mercury in the workplace air. Record the total volume.

5.3.4. Replace the plastic end caps on the active sampler after sampling is completed.

N0007926

5.4. Sample Shipment

5.4.1. Securely wrap each sorbent pouch or active sampling tube end-to-end with an OSHA Form 21 sample seal. Also seal and prepare cassettes if a prefilter assembly was used.

5.4.2. Submit at least one blank sample with each set of samples. The blank sample should be handled in the same manner as the other samples except that an air sample is not taken.

5.4.3. Request the laboratory to analyze the samples for mercury. Submit any pertinent sampling information to the lab. Record if a prefilter assembly was used.

5.4.4. Ship the sealed pouches and used dosimeter housings, or active sampling tubes to the laboratory in appropriate containers as soon as possible. The filter/cassette assembly can also be submitted for mercury particulate analysis; however, sampling periods may be longer than reflected in exposure regulations. The PEL for mercury particulate is a Ceiling (8.14.) and the vapor is a TWA PEL.

6. Analysis

6.1. Safety Precautions

6.1.1. Wear safety glasses, labcoat, and gloves at all times.

6.1.2. Handle acid solutions with care. Avoid direct contact of acids with work area surfaces, eyes, skin, and clothes. Flush acid solutions which contact the skin or eyes with copious amounts of cold water.

6.1.3. Prepare solutions containing hydrochloric acid in an exhaust hood and store in narrow-mouthed bottles.

6.1.4. Keep B.O.D. bottles containing stannous chloride/hydrochloric acid solutions capped when not in use to prevent inhalation of noxious vapors.

6.1.5. Exercise care when using laboratory glassware. Do not use chipped pipets, volumetric flasks, beakers or any glassware with sharp edges exposed.

6.1.6. Never pipet by mouth.

6.1.7. When scoring the glass of active samplers to remove the sorbent before analysis, score with care. Apply only enough pressure to scratch a clean mark on the glass. Use a paper towel or cloth to support the opposite side while scoring. Moisten the mark with DI H₂O and wrap the tube in cloth before breaking. If the tube does not break easily, re-score. Dispose of glass in a waste receptacle specifically designed and designated for broken-glass.

6.1.8. Always purge the mercury from the CV-AAS into an exhaust vent.

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6.1.9. Occasionally monitor the CV-AAS for mercury vapor leaks using an appropriate direct reading instrument.

6.2. Equipment - Cold Vapor Analysis

(Note: Specific equipment is listed for illustration only)

6.2.1. Atomic absorption spectrophotometer (model 503, Perkin-Elmer, Norwalk, CT).

6.2.2. Mercury hollow cathode lamp or electrodeless discharge lamp and power supply.

6.2.3. Biological Oxygen Demand (B.O.D.) bottles, borosilicate glass, 300 mL.

6.2.4. Peristaltic pump, 1.6 to 200 mL range, and controller, 1-100 rpm range (Masterflex model 7553-30 with model 7015 head, Cole-Parmer, Chicago, IL).

6.2.5. Quartz absorption cell, 22-mm (7/8 in) o.d. x 152-mm (6 in) long (part no. 303-3101, Perkin-Elmer).

6.2.6. Heating tape.

6.2.7. Variable transformer 50-60 Hz, 10 A, 120 V input, 0-140 V output, 1.4 kW (Superior Electric, Bristol, CT).

6.2.8. Tygon peristaltic pump tubing (part no. N06409-15, Cole-Parmer) and glass tubing.

6.2.9. Aerator (part no. 0303-3102, Perkin-Elmer).

6.2.10. Chart recorder.

6.2.11. Desiccant (Drierite, W.A. Hammond Drierite Co., Xenia, OH).

6.2.12. Volumetric flasks, volumetric pipets, beakers, and other laboratory glassware.

6.2.13. Automatic pipets, adjustable, 0.1 to 5.0 mL range (models P-1000 and P-5000, Rainin Instruments Co., Woburn, MA).

6.2.14. Glass tube scorer, or needle, 21 to 25 gauge - for removing metal screens in dosimeters or glass wool from tubes. A piece of bent wire can also be used.

6.2.15. Exhaust vent.

6.3. Reagents - All reagents should be at least reagent grade.

Stannous chloride, (SnCl_2)

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6.3.1. Deionized water (DI H₂O), organic-free.

6.3.2. Hydrochloric acid (HCl), concentrated (36.5 to 38%), with a mercury concentration less than 0.005 ppm.

6.3.3. Mercury standard stock solution, 1,000 µg/mL: Use a commercially available certified standard or, alternatively, dissolve 1.0798 g of dry mercuric oxide (HgO) in 50 mL of 1:1 hydrochloric acid and then dilute to 1 L with DI H₂O. Store this reagent in a dark environment, preferably in an amber colored container.

6.3.4. Nitric acid (HNO₃), concentrated (69 to 71%), with a mercury concentration less than 0.005 ppm.

6.3.5. Nitric acid, 1:1: Carefully add equal portions of concentrated HNO₃ and DI H₂O.

6.3.6. Nitric acid, 10%: Carefully add 100 mL concentrated HNO₃ to 900 mL DI H₂O.

6.3.7. Stannous chloride (SnCl₂) solution, 10%: Dissolve 20 g SnCl₂ in 100 mL concentrated HCl. Slowly and carefully pour this solution into 100 mL DI H₂O and then mix well. Transfer and store the final solution in a capped B.O.D. bottle to prevent oxidation. Prepare this solution before each new analysis.

6.4. Glassware Preparation

6.4.1. Clean the B.O.D. bottles and stoppers with 1:1 HNO₃ and thoroughly rinse with DI H₂O prior to use.

6.4.2. Rinse all other glassware with 10% nitric acid and then with DI H₂O prior to use. Air dry all 50-mL volumetric flasks to be used in sample preparation.

6.5. Standard Preparation

6.5.1. Prepare a 1 µg/mL mercury standard by making appropriate ten-fold serial dilutions of the 1,000 µg/mL mercury standard stock solution with 10% HNO₃.

6.5.2. Prepare working mercury standards (ranging from 0.1 to 2.0 µg) and reagent blanks immediately prior to use. A few standards at each concentration should be made. Add an appropriate aliquot of the 1 µg/mL standard to a clean B.O.D. bottle containing enough 10% HNO₃ to bring the total volume to 100 mL. A suggested dilution scheme is given:

N0007929

Mercury Standard (μg)	Aliquot (mL)*	Final Volume (mL)
Reagent Blank	0	100
0.1	0.1	100
0.2	0.2	100
0.5	0.5	100
1.0	1.0	100
1.5	1.5	100
2.0	2.0	100

* Aliquot taken from 1 $\mu\text{g}/\text{mL}$ standard prepared in Section 6.5.1.

6.6. Sample Preparation [Note: A hooked needle or piece of fine wire is useful to remove the dosimeter screen or glass wool (active sampler) and the sorbent particles.]

6.6.1. DOSIMETER

Open each sample pouch and remove the sorbent capsule. Carefully remove the screen from the top of the capsule without losing any sorbent. Carefully pour the sorbent into a clean, dry 50-mL flask without spilling any. Discard the screen and empty capsule.

6.6.2. ACTIVE SAMPLER

Score the tube with a glass tube cutter (also see Section 6.1.7.) and then break open the front section of the tube above the glass wool. An alternative approach to scoring and breaking is to carefully remove the glass wool with a bent wire or needle.

- If a prefilter was not used during sampling, place the glass wool and sorbent into separate 50-mL volumetric flasks.
- If a prefilter was used and the glass wool appears to contain hopcalite or Hydrar, the glass wool can be analyzed along with the sorbent. Carefully transfer the glass wool and sorbent to a 50-mL volumetric flask without losing any of the particles.

6.6.3. Prefilter

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Prepare and analyze any prefilters according to reference 8.14.

6.6.4. Add 2.5 mL of concentrated HNO_3 followed by 2.5 mL concentrated HCl to each volumetric flask [Note: To minimize any loss of mercury through a change in oxidation state, the HNO_3 is added before the HCl (8.5.)].

6.6.5. Gently swirl the sample occasionally for approximately 1 h. If Hydrar[®] was used to collect the sample, the dark brown solution will also contain some undissolved clear to white-tan colored ceramic material.

6.6.6. Carefully dilute to a 50-mL total volume with DI H_2O . The final sorbent sample solution will be light blue or blue-green. This is a good place to stop

if the analysis cannot be completed the same day.

6.7. Analysis - Instrument Parameters

6.7.1. Set up the CV-AAS as illustrated in Figure 1.

6.7.2. Wrap the heating tape around the quartz cell and then turn on the variable transformer. The heat setting on the tape should be sufficient to prevent water vapor condensation in the absorption cell.

6.7.3. Place the aerator in a B.O.D. bottle which contains approximately ½ to 1 inch of desiccant. Operate the peristaltic pump for approximately 30 min at full speed to remove any water vapor from the system.

6.7.4. Operate the hollow cathode or electrodeless discharge mercury lamp at the manufacturer's recommended current or power rating.

6.7.5. Use the following settings (Note: The mentioned instrument settings are for specific models used at the OSHA-SLCAL. If instrumentation other than what is specified in Section 6.2. is used, please consult the instrument manufacturer's recommendations.):

Atomic Absorption Spectrophotometer:

Slit	0.7 nm
Signal	Repeat Mode
Function	ABS
Mode	ABS
Range	UV
Wavelength	253.7 nm
Filter	Out
EM Chopper	Off
Phase	Normal

Strip Chart Recorder:

Chart Speed	5 mm/min
Chart Range	10 mV

6.7.6. Optimize the ENERGY meter reading at 253.7 nm.

6.7.7. Align the beam of the mercury lamp so it passes directly through the center of the quartz cell windows. This can be accomplished by adjusting the burner height, depth, and angle knobs to give a minimum ABSORBANCE reading.

6.7.8. Operate the peristaltic pump at full speed. Rinse the aerator with DI H₂O and insert it into a holder in the exhaust vent.

6.7.9. Perform the following steps to obtain a baseline signal near an absorbance of zero:

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1. start the chart recorder,
2. set the spectrophotometer absorbance reading to zero,
3. wait until the baseline stops drifting,
4. set the reading to zero again.

6.8. Analysis

6.8.1. Samples: Immediately before analyzing, transfer an appropriate aliquot of the sample solution to a clean B.O.D. bottle containing enough 10% HNO_3 solution to bring the total volume to 100 mL. The transfer must be done with a volumetric pipet.

6.8.2. Standards: Immediately before analyzing, prepare standards according to instructions listed in Section 6.5.2.

6.8.3. Deliver 5 mL of the 10% SnCl_2 solution with an automatic pipet to a B.O.D. bottle containing a standard, reagent blank, or sample to be analyzed. Immediately place the aerator into the solution with the peristaltic pump operating at full speed.

6.8.4. Record the maximum absorbance reading and label the signal produced on the strip chart.

6.8.5. Stop the pump, remove the B.O.D. bottle from the CV-AAS and stopper it. Rinse the aerator with DI H_2O and insert it into a holder in the exhaust vent. Turn the pump on at full speed until the CV-AAS system is purged of mercury and the baseline returns to zero.

6.8.6. If the absorbance reading of a sample is greater than the highest standard at any time during analysis, immediately remove the B.O.D. bottle from the CV-AAS. Purge the system following the procedure listed in Section 6.8.5. Take a smaller aliquot or dilute the high concentration sample and re-analyze. Make any necessary sample dilutions with 10% HNO_3 and use the appropriate dilution factor when calculating results.

6.8.7. Repeat Sections 6.8.3. through 6.8.5. for each prepared standard, reagent blank, or sample.

6.9. Analytical Recommendations

6.9.1. It is recommended to analyze the reagent blank, lowest, and highest standard two or three times each to check for contamination, reproducibility, and sensitivity before starting the sample analysis. A 2.0- μg mercury standard should give a three-quarter to full-scale deflection on the chart recorder and an absorbance unit reading of about 0.850 when using the equipment and conditions specified. The lowest and highest standard should provide a linear response and the lowest standard should be at least two to three times the blank signal.

6.9.2. It is also recommended to analyze an entire series of standards (including the reagent blank) at the beginning and end of the sample analysis to ensure standard readings are reproducible. As a general

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guideline, standard readings should be within $\pm 10\%$ throughout the analysis.

6.9.3. A standard near the concentration range of the samples should be analyzed after every four to five samples.

6.9.4. *Quality control (QC) samples should be prepared and analyzed using the same matrix and analytical conditions as the samples. If possible, the QC samples should be generated from an independent source.*

6.9.5. Approximately 10% of the samples should be reanalyzed.

7. Calculations

7.1. Use a least squares regression program to plot a concentration-response curve of peak absorbance versus the amount (μg) of mercury in each standard.

7.2. Determine the amount (μg) of mercury, A , corresponding to the peak absorbance in each analyzed sample aliquot from this curve.

7.3. Calculate the total amount (μg) of mercury, W , in each sorbent or glass wool sample:

$$W = \frac{(A) (\text{sample volume, mL}) (DF)}{(\text{aliquot, mL})}$$

Where:

DF = Dilution Factor (if none, DF = 1)

7.4. A blank correction is made for each sample (Note: When using the reagents and conditions specified, previous blank results have been less than 1 μg). Calculate the concentration of mercury in each sorbent or glass wool sample:

$$\text{mercury mg/m} = \frac{W - W_b}{\text{air volume, L}}$$

Where:

W_b = Total μg of mercury in the blank sample.

Air vol = Sampling time \times flow rate (for ACTIVE SAMPLERS)

(Note: For PASSIVE DOSIMETERS, the sampling rate is affected by temperature and pressure. To correct for this, use:

$$\text{Air vol} = ST \times 0.020 \times (T_1/T_2)^{1.5} \times (P_2/P_1)$$

Where:

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ST = Sampling time (min)
 0.020 = Sampling rate (L/min) at 20 °C and 760 torr
 T_1 = Sampling site temperature (K)
 T_2 = 293 K
 P_1 = Sampling site pressure (torr)
 P_2 = 760 torr

7.5. Reporting Results to the Industrial Hygienist

For PASSIVE DOSIMETER samples, report results to the industrial hygienist as mg/m³ mercury vapor.

For ACTIVE SAMPLERS, report results as:

- a. mg/m³ mercury vapor
- b. mg/m³ total mercury

For mercury vapor result a): If a prefilter was used and the glass wool and sorbent were combined:

$$\text{mercury vapor} = \text{glass wool} + \text{sorbent}$$

The prefilter (if used) was present during sampling to assure that mercury particulate was not trapped in the glass wool.

For total mercury result (b): The sum of the mercury found in the sorbent (vapor), glass wool, and prefilter (if used) for each active sampler is considered. This result is used to determine compliance to the Transitional PEL for total mercury. The Transitional PEL considers both the vapor and particulate fractions of mercury.

Any mercury particulate found on the prefilter can be assessed for compliance with the Ceiling PEL for mercury. See reference 8.14. for further details.

If sampling information has not been provided by field personnel, results are reported in total micrograms.

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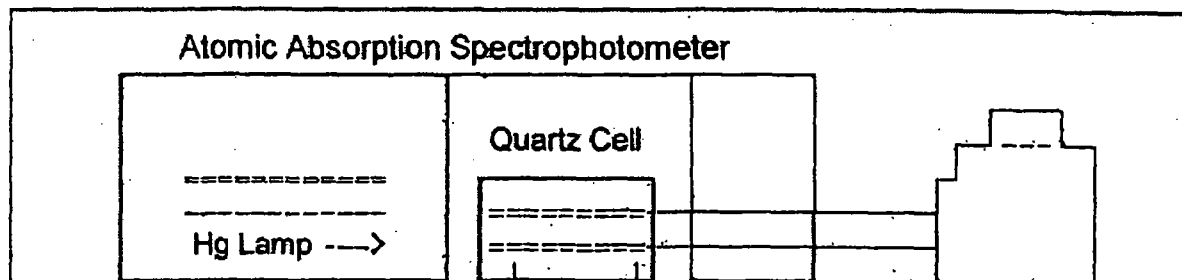
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Cold Vapor-Atomic Absorption Spectrophotometer for Mercury Analysis



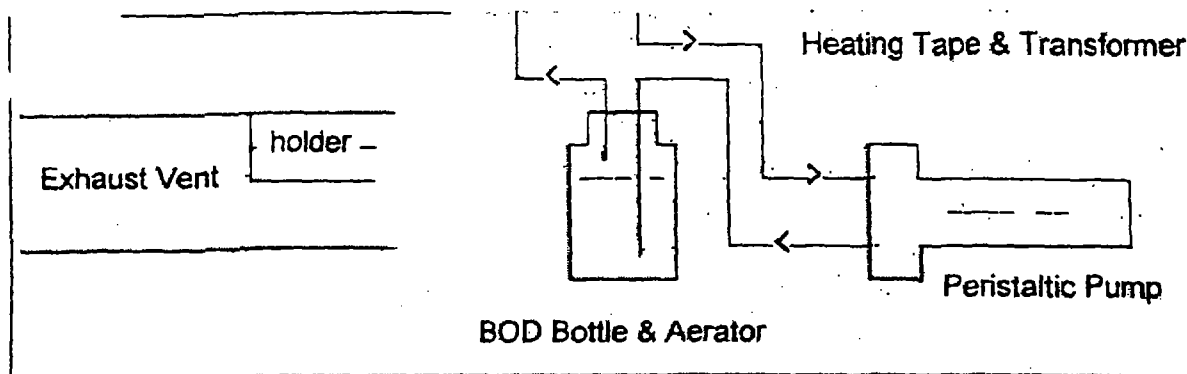


Figure 1

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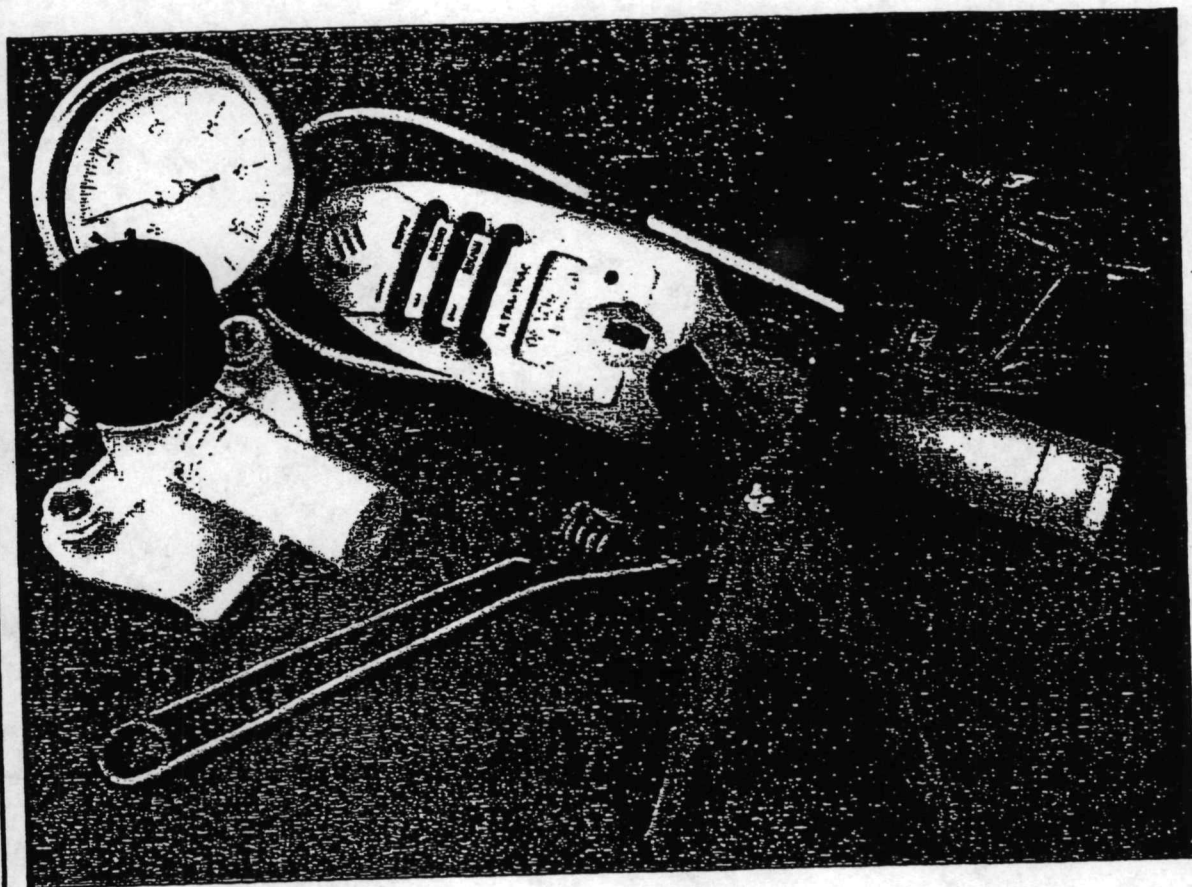
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APPENDIX G
NICOR-INSTRUMENT MERCURY
INSPECTION PROCEDURE – TT6049

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nicor
G A S

Technical Training Center



Instrument mercury
inspection procedure
TT 6049

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September 2000

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Jerome® model 411 mercury inspection procedure

Overview

Background Nicor Gas has initiated a widespread campaign to inspect the homes of our customers for the presence of mercury potentially spilled during the removal of old-style mercury regulators. This is being done in an effort to put the safety of our customers first and address customer concerns in an effective, responsible manner.

Your role As an instrument inspector, you will be an important link in the mercury detection chain. Your responsibilities will include:

- Providing the customer with information about Nicor's pro-active stance on the mercury issue.
- Addressing customer concerns in a courteous manner.
- Informing the customer of the resources Nicor has made available to them should they have questions/concerns.
- Performing an instrument inspection for the presence of mercury vapor in the customer's home.
- Applying a mercury suppressant to any elemental mercury that you observe.
- Completing paperwork reflecting your findings in the customer's home.

Customer resources Nicor Gas mercury information line:
1-888-288-8110
Special mercury information section on the Nicor website:
www.nicor.com
Illinois Department of Public Health consumer information line:
1-888-522-1282

Mercury exposure limits The table below lists mercury exposure limits from a variety of sources.

Source	P.E.L. (Permissible Exposure Limit)
US- OSHA	.100 mg/m ³ .
NIOSH	.050 mg/m ³ as an 8-hour TWA (time weighted average).
ACGIH	.025 mg/m ³ as an 8-hour TWA.
IDPH	.010 mg/m ³ occupancy allowed during cleanup.
ATSDR	.0003 mg/m ³ lifetime exposure.

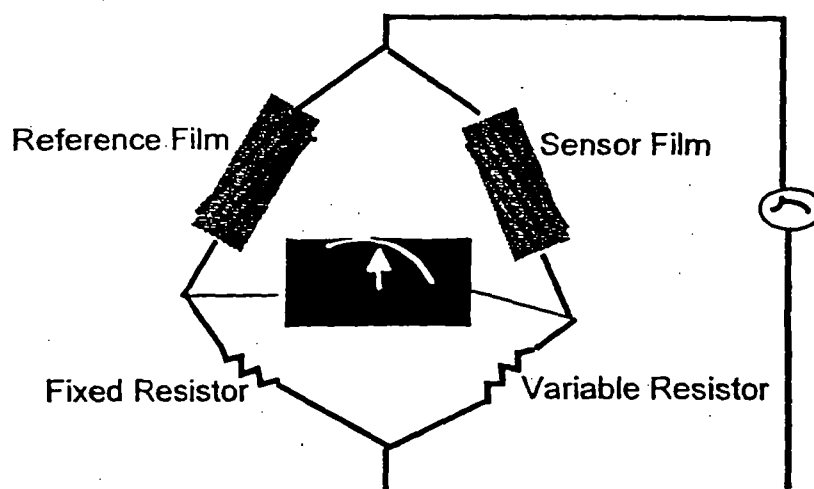
Jerome® model 411 information

Principle of detection

- The Jerome® 411 uses a thin gold film as the principle means of mercury detection.
- A change in resistance of the gold film indicates the presence of mercury vapor.
- The gold film is selective to mercury.
- The gold film is extremely sensitive to mercury at a level of $.003 \text{ mg/m}^3$.
- Mercury forms a surface alloy on the gold film. When heated, the Hg is thermally desorbed and the gold returns to its base resistance.

Wheatstone bridge

Hg increases the resistance of sensor film, causing an imbalance in the bridge.



Specifications The table below lists Jerome® 411 specifications

Category	Specification
Sensitivity	$.003 \text{ mg/m}^3$
Range	$.003 \text{ to } 1.999 \text{ mg/m}^3$
Resolution	$.001 \text{ mg/m}^3$
Flow rate	750 cc/min.
Operating temperature	$0\text{--}40^\circ\text{C.}$

Continued on next page

Jerome® model 411 information, Continued

Internal battery pack

- The internal battery pack will operate the Jerome® 411 continuously for about 6 hours on a full charge.
 - An additional battery pack is required for operation longer than 6 hours.
 - The internal battery pack should be charged for a period of 14 hours to reach full charge.
 - The internal battery pack uses NiCad rechargeable batteries.
-

Accessories

You will use the following accessories along with the Jerome® 411:

- Zero air filter.
 - Internal acidic gas & scrubber filter (you will not need to do anything with this filter).
 - Dust (fritware) filter.
 - Battery charger.
 - Line cord.
 - Trimmer tool.
 - Probe.
-

Before you begin each day

Film heat procedure

The table below lists the steps to follow to perform a film heat (sensor regeneration) procedure.

- The film heat procedure cleans the gold film and re-energizes the sensor.
- The film heat procedure **MUST BE** performed at the beginning of each day, whenever the sensor becomes saturated, and every night.

Step	Action
1	Replace the dust (Fritware) filter.
2	Connect the battery charger and power cord to the back of the Jerome® 411.
3	Plug both cords into a 120 V outlet. <ul style="list-style-type: none">• <i>Avoid outlets in the kitchen or where vacuums, refrigerators, microwaves, etc. share the circuit.</i>
4	Install the zero filter into the unit's intake.
5	Press the ON button.
6	Press the Film Heat button. <ul style="list-style-type: none">• <i>Display flashes ".H.H.H" for about 10 minutes.</i>• <i>DO NOT interrupt this procedure once it has started.</i>
7	Press the OFF button and unplug both cords from the Jerome® 411 and the outlet.
8	Remove the zero filter.

Continued on next page

Before you begin each day, Continued

Balancing procedure

The table below lists the steps to follow to balance the instrument.

- Balancing should **ONLY** be performed following film heat procedures.
- Balancing **MUST BE** performed after every film heat procedure performed throughout your day.
- The unit should be allowed to cool off for at least 15 minutes prior to balancing.
- Remember to take the bridge balance through a range before setting it at .04.

Step	Action								
1	Ensure that the unit has had at least 15 minutes to cool off following the film heat (sensor regeneration) procedure.								
2	Press the ON button.								
3	Press and hold the Sensor Status button. <table><tr><th>If the display reads...</th><th>Then you should...</th></tr><tr><td>Greater than .04</td><td><ul style="list-style-type: none">• Turn the bridge balance counter-clockwise until the display reads .04</td></tr><tr><td>Less than .04</td><td><ul style="list-style-type: none">• Turn the bridge balance clockwise until the display reads .04</td></tr><tr><td>.04</td><td><ul style="list-style-type: none">• Do nothing; the instrument is balanced.</td></tr></table>	If the display reads...	Then you should...	Greater than .04	<ul style="list-style-type: none">• Turn the bridge balance counter-clockwise until the display reads .04	Less than .04	<ul style="list-style-type: none">• Turn the bridge balance clockwise until the display reads .04	.04	<ul style="list-style-type: none">• Do nothing; the instrument is balanced.
If the display reads...	Then you should...								
Greater than .04	<ul style="list-style-type: none">• Turn the bridge balance counter-clockwise until the display reads .04								
Less than .04	<ul style="list-style-type: none">• Turn the bridge balance clockwise until the display reads .04								
.04	<ul style="list-style-type: none">• Do nothing; the instrument is balanced.								

Inspection procedure (throughout your day)

- Sample mode**
- You should use **sample mode** to take ALL of your readings.
 - Sample mode produces optimum accuracy.

Threshold readings

The table below lists the steps to follow to take threshold readings.

- A minimum of three threshold readings are required acclimate the instrument to the home.
- You need to observe two consecutive readings of less than .003 each before continuing the inspection procedure with actual readings.

Step	Action						
1	Enter the customer's home.						
2	Install the zero filter.						
3	Press the ON button. <ul style="list-style-type: none"> Display reads "000". Allow 1 minute for electronics to warm up. 						
4	Press the Sample button. <ul style="list-style-type: none"> Display shows elapsed time. 						
5	Record the reading.						
6	Take and record additional readings (there is space to record up to 5 on your inspection sheet). <table border="1"> <thead> <tr> <th>If...</th><th>Then you should...</th></tr> </thead> <tbody> <tr> <td>You observe two consecutive readings of less than .003 each.</td><td> <ul style="list-style-type: none"> Continue the inspection procedure with actual readings. </td></tr> <tr> <td>You are unable to observe two consecutive readings of less than .003 each.</td><td> <ul style="list-style-type: none"> Take the instrument outside. Take and record three readings outside with the zero filter installed. Move on to step 7. </td></tr> </tbody> </table>	If...	Then you should...	You observe two consecutive readings of less than .003 each.	<ul style="list-style-type: none"> Continue the inspection procedure with actual readings. 	You are unable to observe two consecutive readings of less than .003 each.	<ul style="list-style-type: none"> Take the instrument outside. Take and record three readings outside with the zero filter installed. Move on to step 7.
If...	Then you should...						
You observe two consecutive readings of less than .003 each.	<ul style="list-style-type: none"> Continue the inspection procedure with actual readings. 						
You are unable to observe two consecutive readings of less than .003 each.	<ul style="list-style-type: none"> Take the instrument outside. Take and record three readings outside with the zero filter installed. Move on to step 7. 						
7	Evaluate your outside readings. <table border="1"> <thead> <tr> <th>If...</th><th>Then...</th></tr> </thead> <tbody> <tr> <td>All three outside readings are less than .003.</td><td> <ul style="list-style-type: none"> Your instrument is working properly. The elevated readings inside are most likely interferences ("false positives"). Inform your team leader of the situation. </td></tr> <tr> <td>Any of the three outside readings are .003 or greater.</td><td> <ul style="list-style-type: none"> Your instrument may be malfunctioning. Inform your team leader of the situation. </td></tr> </tbody> </table>	If...	Then...	All three outside readings are less than .003.	<ul style="list-style-type: none"> Your instrument is working properly. The elevated readings inside are most likely interferences ("false positives"). Inform your team leader of the situation. 	Any of the three outside readings are .003 or greater.	<ul style="list-style-type: none"> Your instrument may be malfunctioning. Inform your team leader of the situation.
If...	Then...						
All three outside readings are less than .003.	<ul style="list-style-type: none"> Your instrument is working properly. The elevated readings inside are most likely interferences ("false positives"). Inform your team leader of the situation. 						
Any of the three outside readings are .003 or greater.	<ul style="list-style-type: none"> Your instrument may be malfunctioning. Inform your team leader of the situation. 						

Continued on next page

Inspection procedure (throughout your day), Continued

Actual readings

The table below lists steps to follow to take actual readings inside of a customer's home.

Step	Action						
1	Remove the zero filter.						
2	<p>Proceed through the home, guided by your inspection sheet, taking and recording readings.</p> <table> <tr> <th>If you observe...</th><th>Then you should...</th></tr> <tr> <td>Any reading of .003 or greater.</td><td> <ul style="list-style-type: none"> Take and record two more readings in the same location. Install the zero filter, take and record three readings in the same location. Remove the zero filter, take and record three more readings in the same location. Proceed to step 3. </td></tr> <tr> <td>That all readings in the home are less than .003</td><td> <ul style="list-style-type: none"> Inform the customer that their home is clear. Inform the customer that they should call the customer mercury line (1-888-288-8110) with any questions. </td></tr> </table>	If you observe...	Then you should...	Any reading of .003 or greater.	<ul style="list-style-type: none"> Take and record two more readings in the same location. Install the zero filter, take and record three readings in the same location. Remove the zero filter, take and record three more readings in the same location. Proceed to step 3. 	That all readings in the home are less than .003	<ul style="list-style-type: none"> Inform the customer that their home is clear. Inform the customer that they should call the customer mercury line (1-888-288-8110) with any questions.
If you observe...	Then you should...						
Any reading of .003 or greater.	<ul style="list-style-type: none"> Take and record two more readings in the same location. Install the zero filter, take and record three readings in the same location. Remove the zero filter, take and record three more readings in the same location. Proceed to step 3. 						
That all readings in the home are less than .003	<ul style="list-style-type: none"> Inform the customer that their home is clear. Inform the customer that they should call the customer mercury line (1-888-288-8110) with any questions. 						
3	<p>Compare your readings taken with and without the zero filter.</p> <table> <tr> <th>If...</th><th>Then you...</th></tr> <tr> <td>Readings taken with the zero filter installed are each less than .003 and readings taken without the zero filter installed are each .003 or greater.</td><td> <ul style="list-style-type: none"> Can be reasonably sure that you have detected mercury vapor and you should proceed accordingly. Should replace the dust (Fritware) filter before inspecting the next home. </td></tr> <tr> <td>Readings taken with and without the zero filter installed are all .003 or greater.</td><td> <ul style="list-style-type: none"> Can be reasonably sure that you have detected a "false positive" and you should proceed accordingly. </td></tr> </table>	If...	Then you...	Readings taken with the zero filter installed are each less than .003 and readings taken without the zero filter installed are each .003 or greater.	<ul style="list-style-type: none"> Can be reasonably sure that you have detected mercury vapor and you should proceed accordingly. Should replace the dust (Fritware) filter before inspecting the next home. 	Readings taken with and without the zero filter installed are all .003 or greater.	<ul style="list-style-type: none"> Can be reasonably sure that you have detected a "false positive" and you should proceed accordingly.
If...	Then you...						
Readings taken with the zero filter installed are each less than .003 and readings taken without the zero filter installed are each .003 or greater.	<ul style="list-style-type: none"> Can be reasonably sure that you have detected mercury vapor and you should proceed accordingly. Should replace the dust (Fritware) filter before inspecting the next home. 						
Readings taken with and without the zero filter installed are all .003 or greater.	<ul style="list-style-type: none"> Can be reasonably sure that you have detected a "false positive" and you should proceed accordingly. 						

Ending your day

Film heat procedure

The table below lists the steps to follow to perform a film heat (sensor regeneration) procedure.

- The film heat procedure cleans the gold film and re-energizes the sensor.
- The film heat procedure **MUST BE** performed at the beginning of each day, whenever the sensor becomes saturated, and every night.

Step	Action
1	Connect the battery charger and power cord to the back of the Jerome® 411.
2	Plug both cords into a 120 V outlet. <ul style="list-style-type: none">• <i>Avoid outlets in the kitchen or where vacuums, refrigerators, microwaves, etc. share the circuit.</i>
3	Install the zero filter.
4	Press the ON button.
5	Press the Film Heat button. <ul style="list-style-type: none">• <i>Display flashes ".H.H.H" for about 10 minutes.</i>• <i>DO NOT interrupt this procedure once it has started.</i>
6	Press the OFF button.
7	Leave the unit plugged in overnight to recharge the battery pack.

NOTE: it is not necessary to replace the dust (Fritware) filter at night. You will be replacing it before performing the film heat procedure in the morning.

Three vital points to remember

- Perform film heat procedure at the start and end of each day, or when sensor capacity is full.
- DO NOT balance the instrument during or between samples. This is only done after a film heat procedure.
- DO NOT draw liquids into the instrument.

APPENDIX H
NICOR-MERCURY RESTORATION PROGRAM –
AIR MONITORING LOG

N0007948

TEMPERATURE

INSTRUMENT SERIAL #

DAY: _____

BACKGROUND Hg LEVEL: _____

REL. HUMIDITY _____

[illegible]

PERFORMED BY: _____

SIGNATURE: _____

N0007949

AIR SAMPLING DATA RECORD

A. PERSONNEL SAMPLING INFORMATION

Type of Sample Personal / Area		Operation/Task Monitored	
Sampled		Date of Sampling	
Job Title		Project Name	
SSN		Location of Air Sampling	
Emp #		Person Performing Sampling / Employee #	

B. SAMPLING DATA

Start Calibration (ml/min)	Trial 1	Trial 2	Trial 3	Average	Sample Time	Start	
End Calibration (ml/min)	Trial 1	Trial 2	Trial 3	Average	Sample Time	Start	
Sample #		Pump #			Sample Duration (min)		
Analytes (Contaminants)	Analyze 1	Analyze 2	Analyze 3		Date Sample Shipped to Laboratory		
Sampling/Analytical Method(s) (NIOSH/OSHA) Collection Media		Pump Flow Checks	A.M.	P.M.	Date Sample Shipped to Laboratory		

Remarks: Job description; factors affecting sampling efforts, possible interference, etc.: _____

C. PERSONAL PROTECTIVE EQUIPMENT: () Check all that apply

D. WEATHER CONDITIONS

Eye Protection	<input type="checkbox"/> Safety Glasses <input type="checkbox"/> Goggles <input type="checkbox"/> Face Shield	Ambient Temperature (° F)	
Respirator	<input type="checkbox"/> N/A <input type="checkbox"/> ½ Face APR <input type="checkbox"/> Full-Face APR <input type="checkbox"/> PABR <input type="checkbox"/> SCBA <input type="checkbox"/> Air-Line/Egress SAR	Atmospheric Pressure (in Hg)	
Gloves/Boots	<input type="checkbox"/> N/A <input type="checkbox"/> Sample Latex <input type="checkbox"/> Cotton/Cloth <input type="checkbox"/> Nitrile <input type="checkbox"/> PVC <input type="checkbox"/> Wizard/Cut Resist <input type="checkbox"/> Leather <input type="checkbox"/> Other _____ <div style="text-align: center; font-size: small;">(Specify)</div>	Wind Speed / Direction	
Clothing	<input type="checkbox"/> Level D <input type="checkbox"/> Plain Tyvek <input type="checkbox"/> Polyethylene-Coated Tyvek <input type="checkbox"/> Saranex-Coated Tyvek <input type="checkbox"/> Fully Encapsulated (Level A) <input type="checkbox"/> Acid Gear <input type="checkbox"/> Rain Suit	Relative Humidity (%)	
Other	<input type="checkbox"/> Shin/Toe Guards <input type="checkbox"/> Weldshield/Apron <input type="checkbox"/> Ear Plugs <input type="checkbox"/> Body Harness/Line <input type="checkbox"/> Warning Vest <input type="checkbox"/> Hard Hat <input type="checkbox"/> Steel-Toe Boots <input type="checkbox"/> Other _____ <div style="text-align: center; font-size: small;">(Specify)</div>	Precipitation (in.)	

E. LABORATORY INFORMATION

Laboratory Used/Address/ Telephone Number						
Analytical Results (PPM, mg/m ³)	Analyze 1		Analyze 2		Analyze 3	
	_____ TWA _____ STEL	_____ TWA _____ STEL	_____ TWA _____ STEL			

N0007950

APPENDIX I
SUBCONTRACTOR DAILY SAFETY BRIEFING

N0007951

**NICOR MERCURY RESORATION PROGRAM
DAILY SAFETY BRIEFING LOG**

Date: _____

Contractor: _____

Location: _____

Job No.: _____

Meeting conducted by: _____

Safety topics presented (check as appropriate, use back of sheet if necessary):

☐ Vehicle Safety

☐ Mercury Hazards

☐ Avoiding Customer Confrontation

☐ Emergency Procedures

☐ Vicious Animals/Pets

☐ Slips, Trips, Falls

☐ Utility/Electrical Hazards

☐ Hazard Communication

☐ Confined Spaces

☐ PPE Requirements

☐ Preventing Contamination Spread

☐ Decontamination Procedures

☐ Inclement Weather

☐ Insect Bites

☐ Using Small Tools

☐ Lifting Heavy Objects

☐ Avoiding Cuts from Sharp Objects

☐ Heat Stress/Cold Stress

☐ Media Relations

☐ Children's Safety

Other topics presented: _____

ATTENDEES:

Name Printed and Employee Number:

Signature:

N0007952

